Developing Total Productive Maintenance Model (TPM) For Small Medium Size Enterprises (SME)

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Abstract

In this research a developed TPM (Ladder) model is presented, this model activates both Safety Health environment (SHE) and Training pillars through the rest six pillars. The developed model is directed to Small Medium Size Enterprises (SME)s as these enterprises suffer from poor management and lack of training. Throughout this model the other six remaining TPM pillar are embraced between training and SHE pillars and overlapped [Planned Maintenance (PM), Autonomous Maintenance (AM), 5S, Quality Maintenance (QM), Office TPM, and KAIZEN]. This overlapping is where some conjugated activities for these six pillars are shared, merged, and counter parted. Therefore, all TPM pillars are integrated horizontally, vertically, and in-between reducing cost, time, and human resources towards lean goal.

Keywords

TPM, LEAN, SME, SHE, TRAINING

1. Introduction.

SMEs often vary by country and are usually based on the number of employees, the annual turnover or the value of assets of enterprises. Small enterprises are those that have ten to 100 employees and medium-sized enterprises are those with 100 to 250 employees. Unless otherwise specified, the definition of an SME is any enterprise with fewer than 250 employees [1]. While European Union (EU) defines (SME)s as enterprises which employ fewer than 250 persons and which have an annual turnover not exceeding 50 million Euros, and/or an annual balance sheet total not exceeding 43 million Euros [2]. The value of the small business sector is recognized in economies world-wide, irrespective of the economy's developmental stage. The contribution towards growth, job creation and social progress is valued highly and small business is regarded as an essential element in a successful formula for achieving economic growth.

It is estimated that SMEs employ 22% of the adult population in developing countries. In addition, SMEs suffer from poor management skills due to lack of adequate training and education [1, 3].

The challenges posed by the contemporary competitive environment, as other manufacturing organizations, where SMEs must infuse quality and performance improvement initiatives in all aspects of their operations to improve their competitiveness [4]. Since the inadequacies of the maintenance practices adversely affect organizational competitiveness. Thereby reducing throughput, reliability of production facilities, leading to fast deteriorations in production facilities, lowering equipment availability, production quality, and increasing inventory thus leading to unrealizable delivery performance [5]. Productivity plays a crucial role in boosting the growth of the organization and helps them to survive in a competitive world. Nowadays, the managers should be aware in the situation of their company, some tools and techniques that help in improving the productivity value Nakajima [6] defined TPM as innovative strategy of maintenance that optimize equipment effectiveness, eliminates breakdowns, and promotes

autonomous maintenance by operator day-to-day activities involving. TPM can influence the productivity since it is greatly known and acting as a strategy for enhancing manufacturing performance by improving production facilities effectively. TPM affect the productivity throughout the followings; increasing the involvement of employees that follows the improved employees' motivation therefore, enhancing outcome and effectiveness, where waste reduction leads consequently to improvement in the workforces` salaries and job satisfaction. All these lead to effectiveness of organization and boost productivity. Also eliminating inefficiencies of investment, material, and labor lead to productivity and efficiency improvement [5,6, 7]. The next paragraph review literatures that describe the role of TPM, TPM pillars also the evolution of TPM methodologies. A developed TPM called (Ladder) model is presented, where the role of each pillars is presented later. This paragraph is followed by discussion, conclusions, finally further recommendations are stated.

2. Literature Review.

"Five Pillar Model" is proposed earlier by Steinbacher and Steinbach (1993) as shown in Fig. (1). TPM implementation process, at the highest level requires initialization, implementation, and Institutionalization. In this model, "Training and Education" are an integral element of all other pillars rather than stand-alone pillar [8].

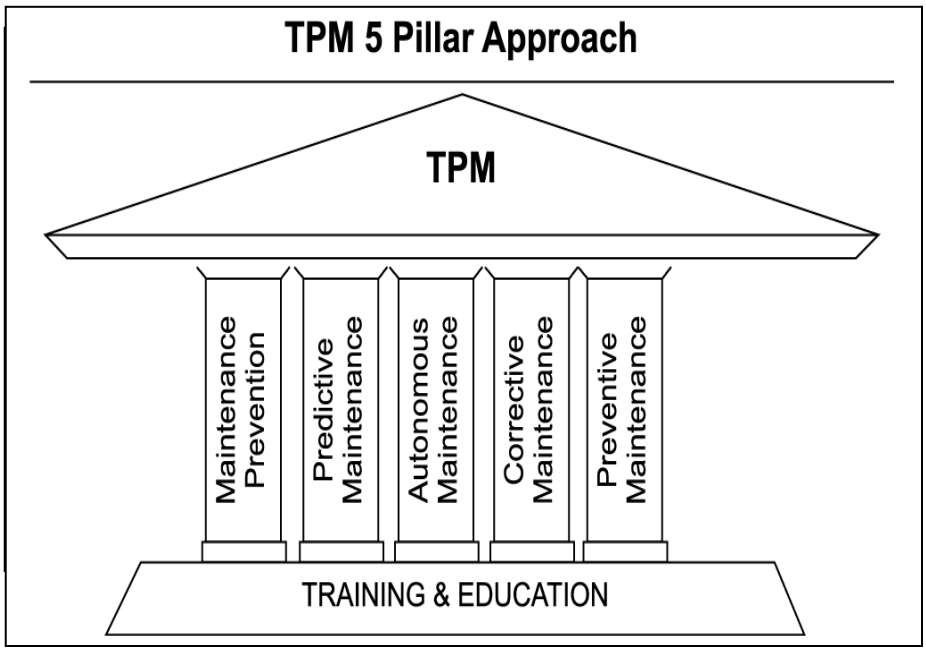

Fig. (1) Steinbacher and Steinbacher Model of TPM Implementation [21].

Pirsig later on (1996) emphasizes seven unique broad elements and four main themes in any TPM implementation program. The key four themes in his model are that TPM implementation program include training, decentralization, maintenance prevention and multi-skilling. While the broad elements of Pirsig model as shown in Fig (2) are; asset strategy, empowerment, resource planning and scheduling systems and procedures, measurement, as well as continuous improvement of processes [9].

Also five-pillar model is introduced by (Yeoman's and Millington 1997) these pillars are; increase equipment effectiveness, training, autonomous maintenance, early equipment management, and planned preventive maintenance.

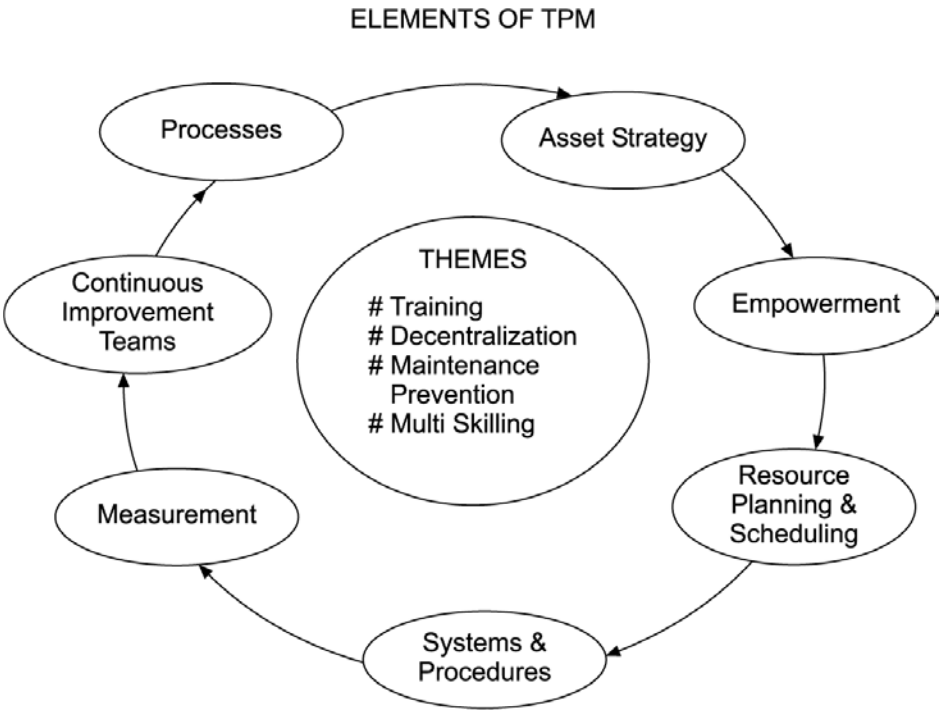

Fig. (2) Pirsig Model of TPM Implementation [9].

Japanese Institute of Plant Maintenance [JIPM] developed the most well-known TPM model of eight pillars; seven of them are based upon 5S pillar as foundation pillar. These pillars are;(planned maintenance, quality maintenance, autonomous maintenance, Kaizen, office TPM, training, and Safety, Health and Environment(SHE)). All the eight these pillars are integrated throughout TPM roof [10,11] as shown in Fig. (3).

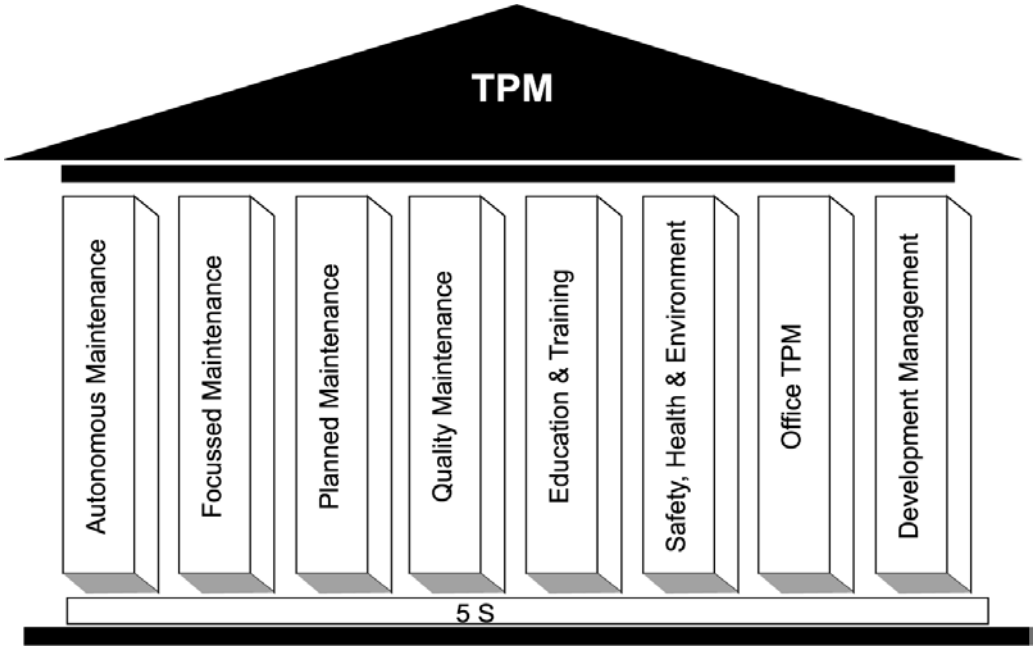

Fig. (3) JIPM Eight Pillars TPM Implementation [11].

5S pillar include Seire (Sort, organization) Seition (Set in order), Seiso (shine, cleaning), Seiketsu (standardize the cleaning),and Shitsuke (Sustain, discipline)also referred to five keys of total quality improvement [12].

Autonomous maintenance pillar aim in making the operator aware of routine maintenance tasks that could help to free the core maintenance team to extract high maintenance activities. If the operators are trained to carry out the basic activities that will increase their skill level, give them more responsibility for operation of the tool, increase their job prospects, and free up technicians to work more complex activities. Throughout time skill will be improved, and autonomous team will step forward to more complex maintenance activities and ensure optimum machine availability [6, 13]

"Quality maintenance is the establishment of conditions that will preclude the occurrence of defects and control of such conditions to reduce defects to zero". JIPM defined Quality maintenance as" the activities that are to set equipment conditions that preclude quality defects, based on the basic concept of maintaining perfect equipment to maintain perfect quality of products" [11].

While Planned Maintenance is the raising of output (with no failures, no defects) and backing up production, so as to produce the required quantity, and quality level. Therefore, maintenance should insure equipment availability. The basic activities of planned maintenance are to support, guide autonomous maintenance throughout planning efficient, and effective preventive, predictive and time base maintenance over equipment lifecycle. Other planned maintenance basic activities are; inspecting, cleaning, and lubricating activities at work place [12, 14, 15].

Whereas Kaizen pillar is practice concept in every activity to achieve cost reduction target in all resources. This concept of zero losses is basically for small improvements, carried out on continuous basis. Kaizen requires no or small investments throughout very large number of small improvements that are more effective than few improvements of large value. Kaizen activities are not limited to production activities but can be implemented in administrative area as well [16].

Maintenance is one of the important pillars in technical management in industry where losses and harms due to lack of a suitable maintenance system, in addition to production reduction are due to equipment's failure, early parts change, human and financial risks for the personnel [7]. Therefore, Safety, Health and Environment (SHE) pillar activities aim to reactively eliminate the root causes of incidents that have occurred, to prevent reoccurrence, and proactively reduce the risk of future potential incidents by targeting near misses and potential hazards [14].

This pillar target three key areas are; people's behaviors, machine conditions and the management system. All SHE pillar activities should be aligned to relevant external quality standards and certifications. The immediate benefits of implementing SHE pillar are to prevent reoccurrence of lost time accidents, reduce the number of minor accidents as well as preventing environmental system failure. This has a direct financial saving in the cost of containment, investigation and compensation as well as reputational impact. SHE pillar is important to note that it is not just safety related but also covers zero accidents, zero overburden (physical and mental stress and strain on employees) and zero pollution [14].

Office TPM pillar aim in formulating effective production system throughout the entire structural activities. Where the required support for production actions and other sections in order to decrease cost, building up competitive, control and improve synergy between various business function should be delivered. Therefore, creation of effective administrative processes by focusing on cost related issues, and developing work process that handle these changes [17, 18].

The training pillar is an integral part of TPM, operators and maintenance training help to eliminate breakdowns that occur due to unavailability of skills. Training will also allow operators to maintain their machines and recognize failure occurrence and they may propose methods to avoid the failure from happening again [19]. The training should focus on [20];

i improvement of knowledge, skills and techniques.
ii. Creating a training environment for self-learning based on felt needs.
iii. Training curriculum/tools/assessment etc. conducive to employee revitalization; and
iv. Training to remove employee fatigue and make work enjoyable.

From the above Literature survey it could be concluded that there are almost common pillars throughout different TPM models theses are; planned maintenance, autonomous maintenance, and training. In Steinbach and Steinbach [21] model training forms the base pillar that is integrated with the other four pillars in their model. In Pirsig [9] model training as well as multi _skilling was part of the central core of the model. Whilst training is standalone pillar in JIPM model [11]. Fast review to the above other seven pillars of JIPM model shows the training activities is

significant in each pillar may be replicated, others may be shared, and the value of continues improvements through training in each individual pillar is recognized.

3. Developed TPM Model

The rapidly changing needs of modern manufacturing and the ever increasing global competition has emphasized upon the re-examination the role of improved maintenance management towards enhancing organization's competitiveness, due to the limited resources of SMEs TPM ((ladder) model is proposed to improve their productivity, offering time cost saving that should be relevant to SMEs as this model is directed to such enterprises. In This developed model in shown in Fig (4), in this model: -

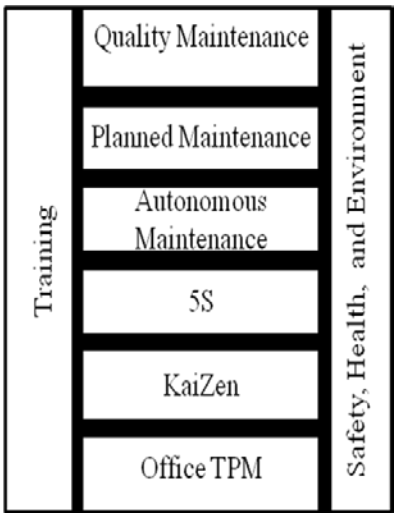

Fig. (4) Developed TPM (Ladder) Model for SMEs.

i. Two main pillars that embrace and integrate vertically the other six pillars are; training and SHE pillars. Although training is an individual pillar it is the driving force toward continuous improvement of human force to increase productivity. Since training activities are already existed in the other six pillars therefore, this integrative structure is to unify, and merge certain activities as in autonomous, 5S, and planned maintenance. Consequently, saving cost and other resource wastage could be resulted.

ii SHE pillar is empowered as a major integrative pillar since safety requirements should always be considered throughout maintenance activities so as to spare workers, and employee's health. Also each activity throughout the rest six TPM pillars should satisfy the requirements of least impact to environment throughout the whole maintenance management activities. Also applicability of this pillar offers three out of four lean enterprise dimensions that are; safety, quality and cost where delivery as the fourth lean dimension should be reflected through the product delivery [22]. Researchers [21, 23] earlier recognized and affirmed the importance of healthy, safe working environment in their TPM definitions. Steinbacher and Steinbacher (1993) [21] defined TPM is "all of the strategies needed to sustain a healthy maintenance log.". While (Cooke 2000) [23] defined TPM "an intended to bring both functions (production and maintenance) together by a combination of good working practices, team working, and continuous improvement.

iii. This model also offers horizontal integration between four pillars at a time that may save cost, effort, and human workforce in SMEs, as between 5S, and autonomous, or planned, and quality maintenance but always there will be the horizontal integration of the two pillars SHE, and training as shown in Fig. (4). Therefore, the merger of identical activities is possible and even sharing, exchanging their relative qualified or skilled workers.

iv. The ladder model offers the opportunity to pass over any required or targeted pillar(s) throughout analysis, or implementation TPM. But always training SHE aspects will be accounted

v. This model offers consolidate communications between pillars, staff, and management that may reduce cost, time therefore, support not only maintenance but production process toward leaning production and increasing productivity.

4. Conclusions and Recommendations for Future work

Conclusions realized from the developed TPM Ladder model are: -

1. This model offers three integrative directions between TPM pillars, vertical through training and SHE pillars that embraces the rest six TPM pillars. This model also offers horizontal integration between four pillars at a time that may save cost, effort, and human workforce in SMEs.
2. This model offers consolidate communications between pillars, staff, and management that may reduce cost, time
3. The integration of identical activities is possible and even sharing, exchanging their relative qualified or skilled workers. Hence reducing replicated work, time, and cost wastage toward lean production

Also it could be concluded that TPM is a dynamic and flexible strategy that could be modified according to the manufacturing environment.

It is recommended to employ the developed model in SMEs and evaluate its performance compared to the common JIPM model. Also future work may be directed toward assessing integrative benefits especially the vertical integration.

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