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Total Product Maintenance in Lean Manufacturing

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ABSTRACT

Changing production management paradigms and the transformation to Lean Manufacturing techniques led to more emphasis on programs like just in time (JIT), total quality management (TQM), engineering economics in equipment design and operation. To meet the goals of the present ambitious industries an innovative Japanese concept known as Total Productive Maintenance (TPM) is ushered. Total productive maintenance marks a breakthrough in the maintenance technology empowering the companies with perfect maintenance of the equipment that obviates abrupt machine breakdowns and quality defects. The paper presents a substantial impact of Total Product Maintenance on the production system in the context of Lean principles which allocate top priority to continuous improved productivity, efficiency and quality. The success of this professional management strategy hinges on, an industrial environment which is ready to take novel challenges and changes for the optimum utilization of machinery. This paper aims to define TPM in detail, evaluate its potential as a maintenance science and its effective implementation resulting in reliable and consistent production equipment. Definite stress is given to the interrelated concepts of TPM and Lean manufacturing and the common targets of cost reduction, enhanced quality, flexibility and durability, time factors and employee participation, equipment performance are well tackled. Thus a creative phase of planning and preventing recurring expenses on machines are minimized leading to uninterrupted operation of equipment.
Introduction

The growing expectations from manufacturing firms have triggered the shift in the technological paradigms and reorganization of companies. A culture that deals more effectively with rapid changes is ushered in. Recognizing system availability as critical issue, maintenance is prioritized to sustain the proper functioning of a physical system. A transition to lean management from a normal industrial agenda sets a new trademark to all production activities. To meet the potential targets laid by the lean concepts we need to implement all the inbuilt lean principles. Some of them being Just- in-Time (JIT), Kaizen, Total Quality Management (TQM), and Total Productive Maintenance (TPM). This paper explore a way in which Total Productive Maintenance can be implemented as a strategy in the maintenance management of physical assets and to maximize productivity in the existing facilities in the lean environment. TPM, the maintenance tool that emerged from the preliminary maintenance program of preventive and breakdown maintenance has created an edge in maintenance technology. TPM in highlighted as a proactive and preventive tool where the maintenance activities are viewed as everyone’s responsibility, thus ensuring accountability in work force. This paper presents findings about the utilization and proper implementation of TPM in the context of lean.

Growing Expectations of Maintenance

As maintenance passes through various levels of refinement there is a growing expectation from the manufacturing firms for a unified approach despite diverse distractions [6]. The technology of maintenance is unending, it’s marked with finding and applying cost effective ways of avoiding performance deterioration. Prior to TPM there were several attempts to boost the maintenance by improving the cost effectiveness of the machine operations. The changing maintenance techniques can be illustrated as a time dependent factor. Fig [1] shows how the emphasis on machine downtime and administrative systems has grown to include many new developments in myriad fields.
1.1 Conventional Maintenance State

The traditional state of an industry prior to the implementation of TPM is marked with many drawbacks. Some of the most common being as listed below

- Routine Machine failures
- Momentary repair is the solution here
- Run to failure mentality
- Production is constantly interrupted due to adjustments
- Decline in processing velocity
- No responsibility taken for tracking losses
- Inadequate training imparted to operators
- Too many minor stoppages

FIG [1]   Different Generations of Maintenance
1.2 Future Maintenance State

Proper implementation of TPM leads to a organized and well equipped firm. Some of the features of the industry where TPM has been successfully implemented are

- Enhanced overall Equipment Effectiveness
- Away from very expensive breakdown maintenance
- Easy access of data to operators enabled by strong planning departments
- Improved ergonomics and safety
- Eliminate major sources of waste
- Enthusiastic involvement of the workforce
- Multi skilled workforce

The Importance of TPM for Manufacturing in the Lean Manufacturing:

TPM Aims at a systematic and coordinated system process for developing a plan for the overall course and direction of an enterprise for the purpose of optimizing the future potential. Closely TPM ensures Lean principles by upholding the multidimensional approach of lean. The central purpose of this process is to assure that the course and direction is well-thought-out, sound and appropriate and to assure that the limited resources of the enterprise (time and capital) are sharply focused in support of that course and direction. TPM focuses on getting the productivity needed from the current equipment assets owned by a manufacturing firm enabling optimum utilization of the available machines. The process encompasses strategy formulation and implementation, the basic factors that play a vital role in lean manufacturing. Choosing to be on par in this competitive world of manufacturing, drives industries to reach a level of performance. Hence TPM coupled with the best features of lean system creates a breakthrough in the maintenance technology.
1.1 Preparatory Phase

Any organization that wishes to achieve rapid, substantial and lasting improvements in maintenance effectiveness must ensure that everyone associated with the operation and maintenance of these assets must profoundly understand both the nature and significance of the changes an innovative system brings up. Initially it is usual to encounter resistance to a new concept. Since quality programs like TPM usually change a firm’s culture, the best approach is to design the overall philosophy of a program, explain the goals to the supervisors and staff and then let the supervisors implement the technology.

1.2 Identifying the Major Losses

Prior to the initial launch of the maintenance programme, it’s always profitable to locate the bottlenecks faced by the company, so that the TPM strategy can be molded as to minimize these critical aspects of a manufacturing firm.

Some of the major losses commonly encountered by present days industries are

- Equipment downtime or machine idling
- Engineering adjustments
- Minor stoppages
- Abrupt breakdowns
- Waste

1.3 Goals of TPM

The transition from a reactive or corrective breakdown maintenance system to a more proactive, preventive system and then on launching productive maintenance laid a foundation to for more flexibility, higher productivity, improved quality and lower costs. TPM targets to accomplish certain fundamentals which make a consequential difference in the organization activities. Some of the TPM goals are to:

- Create an environment to flourish enthusiasm and innovativeness
- Augment interaction between operators, technicians and machines
- Enhance machine reliability and
- Strengthened overall equipment effectiveness
• Aim for zero equipment breakdown
• Reach zero machine downtime state

**TPM Program Methodology**

Selecting a sound methodology augments the probability of productive implementation of the TPM activities. A sequential process of managing various maintenance systems is illustrated in the figure below.

![The TPM program methodology diagram](image)

**FIG [2]  The TPM program methodology**

Identifying different patterns to run a plan is essential. The patterns including accepting the weakness and strengths of the current plant, crew, management team, employee attitude, equipment age, purchase policies and business and political conditions. We should proceed from where we are today.

1.1 Levels of TPM Development

The maintenance management development is based on the mathematical modeling and statistical analysis of equipment [5]. The primary fields of evaluation in the management of

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equipment being reliability and maintenance. Various levels of TPM implementation are formulated; each phase is explained as below.

**FIG [3] TPM Roadmap**

1.1.1 Phase-I Awareness:

> Initiating a TPM program begins with educating the present workforce about the innumerable merits of the productive maintenance system. Some of the basic steps taken are enumerated below

1.1 Training Employees

> Any strategy without support will fail. Thus this management strategy too needs a logistic support which is gained from the employee involvement by rendering potential training to the employees. Employee training is a big part of fruitful maintenance system. An extensive training system is undertaken recognizing that a lot of talent was retiring and that the current skills are obsolete. Thus imparting multi craft and cross functional training to operators and technicians enables tremendous flexibility of processes.
1.1.2. Phase-II Organization

TPM helps organize maintenance tasks by applying the following actions [13]:

- Cultivate a sense of ownership in the operator by introducing autonomous maintenance; the operator takes the responsibility for the primary care of the plant.
- Use Cross-functional teams consisting of operators, maintainers, engineers, and managers to improve individual employee and equipment performances.
- Establish an optimal schedule of clean-up and PM to extend the plant's life span and maximize its uptime.

1.1 Diagnostic Tools

Several diagnostic tools are employed in the productive and preventive maintenance program on a regular scheduled basis.

- Vibration Analysis: The machine trains owned by a company are checked monthly to detect any variations from the last reading.
- Thermography: Locating all the heat generating points and checking them each month with infrared equipment to detect thermal anomalies is a key factor to preclude impending threats to the equipment.
- Fluid Analysis: Samples of fluid from gearboxes, transformers, and other equipment are taken each month for analysis.
- Visual Inspection: Fix scheduled routes for the inspectors to travel and check things such as the presence of coupling guards and the integrity of belts.
- Operational Dynamic Analysis: Various devices are employed to check equipment to make sure its meeting design specifications.
• Electrical Monitoring: Monitoring all electrical components with voltmeters, infrared equipment, and other devices to guarantee their operational integrity.

• Failure Analysis: An analysis is performed to determine why a piece of equipment failed and how that can be countered in the future.

1.1.3. Phase-III Planning

The steps involved in a planned maintenance are illustrated in the fig [4]

![Steps involved in planned maintenance](image)

**FIG [4] Steps involved in planned Maintenance**

1.1.4. Phase-IV Implementation

TPM is commonly associated with autonomous maintenance, where activities which help to improve equipment effectiveness over the entire life of the equipment are stressed. These activities include training, early equipment design, early product design, and focused improvement teams and support group tasks.
TPM implementation plan includes the following steps [13]:

- Announcement of TPM: Management needs to create an ideal atmosphere that supports the introduction of TPM.
- Start a formal Educational Program: All the workforce need to me explained about the TPM activities, benefits, and the importance of individual contribution.
- Create an organizational support structure: Team based activities are essential for a TPM effort. A selected group will promote and sustain TPM actions once they begin. This group needs to include members from every level of the organization from management to the shop floor. This structure will promote communication and will guarantee everyone is working toward the same goals.
- Establish basic TPM policies and quantifiable goals: Analyze the existing conditions and set goals that are Specific, Measurable, Attainable, Realistic, and Time-based
- Outline a detailed master deployment plan: This plan will identify what resources will be needed and when for training, equipment restoration and improvements, maintenance management systems and new technologies
- Improve effectiveness of each piece of equipment. Project Teams will analyze each piece of equipment and make the necessary improvements
- Develop an autonomous maintenance program for operators. Operators routine cleaning and inspection will help stabilize conditions and stop accelerated deterioration
- Develop a planned or preventive maintenance program. Create a schedule for preventive maintenance on each piece of equipment
- Conduct training to improve operation and maintenance skills. Maintenance department will take on the role of teachers and guides to provide training, advice, and equipment information to the teams
- Continuous Improvement: As in any Lean initiative the organization needs to develop a continuous improvement mindset.
Conclusions

Hence a lean integrated TPM provides the competence to achieve another step change improvement in equipment performance. An era of integrated approach pulls together all of the design tools and maintenance tools that exist into one whole. Venturing into TPM values paves a way to formal approach to risk assessment, abrupt stoppages and realiability centered maintenance. In addition, human factors as applied to the operation and equipment maintenance yield better results. The integration of Lean and TPM can be taken a step further by evaluating the coordination of the maintenance function with production planning, inventory management, staffing support, engineering and design. In closing we make quite a few observations about TPM’s challenge to researchers. Applying operations management research methodologies to TPM seems to be a better option.

References

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