

Implementation of the Total Productive Maintenance System at Russian Enterprises

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Abstract— This article examines the significance of the implementation of the system of total productive maintenance (TPM), the concept of the TPM system, tools for lean manufacturing, the history of the concept, the purpose of implementation, the stages of implementation. The work of any industrial enterprise is problematic if equipment breaks down and low-quality products are produced. To ensure productive work, it is necessary to take measures to prevent breakdowns and maintain conditions for working in the staffing table.

Keywords— equipment maintenance, TPM system, lean manufacturing, 5C system, engineer, quality management

I. INTRODUCTION

The state of technical equipment and its performance has the most important role in the production of products, because failure may lead to failure of contractual terms, and, consequently, to production costs, due to which the company may incur losses.

During operation, equipment tends to become dirty and wear, which significantly reduces productivity and economic efficiency. Untimely maintenance, pollution and the absence of various types of repairs lead to emergencies or, in the worst case, to man-made disasters. [1]

Rational organization of work on the maintenance of expensive equipment requires no small costs and efforts. Late service entails big expenses, while very frequent maintenance can cost a lot of money. Therefore, the equipment must always be in a state of operational readiness. Thus, the cost of repair requires the implementation of a rational, economic, well-organized and well-established system of preventive maintenance processes. [2]

II. CONCEPT OF TPM SYSTEM

TPM is Japanese concept. The origin of TPM can be traced back to 1951, when preventive maintenance of equipment was

introduced in Japan. Moreover, the concept of preventive maintenance was adopted in the USA.

Nippon Denso, the supplier of components and assemblies for TOYOTA, was the first Japanese company to use the new campaign from 1960, later called Total Productive Maintenance (TPM).

Preventive system maintenance uses equipment. The equipment has a group that serves these machines. However, with the use of automation in Nippon Denso, maintenance became a problem because there was not enough maintenance staff. Thus, management decided that the operators will conduct routine maintenance of equipment. [3]

Then Nippon Denso organized quality circles with the participation of employees. Thus, all employees participated in the implementation of production services. Based on these developments, Nippon Denso was awarded by the Japanese Institute of Plant Engineers (JIPE) an outstanding plant award for developing and implementing TPM. Nippon Denso is the first company to receive a TPM certificate.

Total Productive Maintenance (TPM) is a management concept for production equipment aimed at improving the efficiency of maintenance. The method of universal maintenance of equipment is built on the basis of stabilization and continuous improvement of maintenance processes, a system of scheduled maintenance, work on the principle of "zero defects" and the systematic elimination of all sources of losses.

In the absence of this system, maintenance and care of equipment is assigned to service personnel. The service personnel include maintenance technicians who perform routine maintenance, commissioning and repair of machines and devices. With TPM, some of the functions of the service personnel are transferred to machine operators to detect timely changes in equipment operation, detect and prevent breakdowns. Thus, machine operators are the best source of feedback on the technical condition of the equipment. [4]

These are the tasks that the TPM system solves:

In lean manufacturing, the TPM system fights against losses associated with equipment:

If we consider the management of equipment maintenance more broadly, then the effect of it across the enterprise is as follows:

- Improving machine efficiency;
- Improving workshop performance;
- Reducing the cost of production;
- Improving product quality [5].

III. LEAN MANUFACTURING TOOLS

TPM is one lean manufacturing tool to improve production performance.

1. Just in Time is an approach to production management based on consumer demand. It allows you to produce products in the required amount at a certain time.

2. Kaizen is an approach to managing an organization based on continuous improvement in quality. With this approach to management, employees systematically participate in the improvement of their own activities. [6]

3. 5S is an improvement technique that is included in Kaizen approach. It solves the problem of excess costs associated with a poorly organized workplace.

4. Andon is the visual concept of feedback on production. This system gives the right to all employees to monitor production status. In case of complications, it allows employees to take responsibility and suspend production.

5. Kanban is a concept based on adjusting the flow of material resources inside and outside the enterprise (suppliers, customers). It provides an opportunity to reduce the costs associated with stocks and overproduction [7]

6. SMED (Single Minute Exchange of Die) is a concept that reduces time loss. It is based on the installation of blanks. It is considered a component of the Kaizen approach.

7. Poka-Yoke is a method for modeling errors and preventing them in production processes. It reduces losses due to defects in production. [8]

One of the main concepts of lean manufacturing, which provides a high level of equipment condition, is considered the Total Productive Maintenance (TPM). The use of this tool allows you to minimize losses resulting from equipment downtime due to regular breakdowns and unnecessary maintenance.

The TPM system is based mainly on the 5S system. This is an element of the production system of the enterprise, which has the principles of rational organization of the working space.

The task of implementing the 5S system is the rational organization of the working space.

The task of implementing the 5S system:

1. Getting the most out of available resources.

2. Maximum staff involvement in the continuous improvement process.

3. Elimination of losses during the execution of work operations (for example, transfer of unnecessary stocks, their sorting, etc.).

1S - Sorting - the first stage of the 5S system. At this stage, the workplace is cleaned out of all things that are not needed when performing the current production operations. There is a separation of necessary items from unnecessary and removal of the latter. Red Label Campaign is the method by which 1S-Sorting is performed. The red label zone is a place to store extra items marked with a red label until decisions are made..

2S - Order - the second stage of the 5S system. At this stage, storage sites are organized so that it is comfortable to use objects. Each of them has its place and the required number.

3S - Cleaning / Observation - the third stage of the 5S system. It covers the process of cleaning and maintenance of equipment.

4S - Standardization - the fourth stage of the 5S system. At this stage, cleanliness standards are developed to maintain order.

5S - Improvement - the fifth stage of the 5S system. The goal of this phase is to make it a habit to follow established procedures.

Implementing these principles, management makes such predictions as:

1. Improving customer's satisfaction;
2. Building effective and mutually beneficial relations between suppliers and consumers; - Loss reduction;
3. Increasing competitiveness; - Improve working conditions;
4. Increased interest and satisfaction of workers, etc.

Risks that management may face:

1. The implementation plan is poorly developed;
2. Misunderstanding of the principles and components of the concept;
3. Insufficient staff involvement;
4. A complex interaction;
5. The organizational structure is poorly developed; - Low labor potential;
6. Lack of leadership qualities, etc.

IV. LEVELS AND APPROACHES

A feature of the TPM technique is the possibility of a smooth transition from an older service system to a more advanced one. In the event of a sudden transition, there is a possibility of an error, and this may entail a shutdown of the

enterprise. Specific goals are usually created for TPM implementation. Below is a description of the main stages.

- a) Operational repair of faults - the desire to improve the existing service system and find its weak areas;
- b) Service based on forecasts - coordinating the collection of data on equipment problems and its subsequent analysis. Making a plan for equipment maintenance;
- c) Correcting service - improving the quality of equipment during service and eliminating regular malfunctions;
- d) Autonomous service - the separation of the functions of equipment maintenance between staff;
- e) Continuous improvement is an indispensable attribute of each of the tools of lean manufacturing. This is the involvement of personnel in the process of continuous search for sources of operating and maintenance costs, as well as the selection of different methods for their elimination;

However, the concept of TPM is not only the maintenance and care of equipment, but it is also:

- Creating a system where all types of costs are prevented;
- Corporate life organization;
- Involvement of all departments and branches of the organization;
- Involvement of all employees from director to employee;
- Elimination of production costs;
- An important element of the equipment care concept is equipment maintenance. These manipulations are impossible without spare parts, tools, accessories.

V. PURPOSE OF TPM IMPLEMENTATION

- 1) Creating a system in which everyone personally and voluntarily participates in the care of equipment and works to eliminate the four main reasons for its inefficiency (breakdowns, problems with casting, tool replacement time and defects);
- 2) Improving problem-solving skills with maintenance teams, as well as participating in a Kaizen strategy that aims to eliminate breakdowns;
- 3) Improving development opportunities in areas such as tools and press molds, tool change times, tool design, defects and repair;
- 4) Elimination of the chance of the causes of the six types of losses: emergency equipment failure, changeovers and adjustments, suspensions, reduction in the speed of equipment, scrap, waste of raw materials, etc. (first level of goals);
- 5) Increased equipment efficiency coefficient (second level of goals);
- 6) Implementation of the production plan, compliance with the supply chain, improving product quality, reducing costs,

preventing injuries and accidents, protecting the environment (preventing industrial disasters) (third level of goals);

- 7) Improving business performance and the formation of decent jobs for workers in the organizational and technological areas (the fourth level of goals).

VI. STAGES OF INDEPENDENT SERVICE OF EQUIPMENT BY OPERATORS

Deploying self-maintenance equipment by operators is carried out step by step. Each step corresponds to the skill level of the employee and equipment maintenance work.

Moreover, the higher management evaluates the passage of any step of self-service in a form of diagnostics.

If it meets the requirements, a worker can proceed to the next step.

Steps 1-3 are the basic conditions for normal equipment operation (cleaning, lubrication) and measures to prevent forced wear.

Steps 4-5 are an increase in the efficiency of equipment operation, the transition to the assessment and measurement of the degree of wear of components and parts. Raising the level of work becomes possible because new standards of general testing are revised and added to the old standards on cleaning - testing and lubrication (developed in steps 1-3).

Step 6 is the shift of focus from working with equipment that has been carried out up to this point, to actions on integrated streamlining (including standardization, as well as work with information). In other words, the focus is on the administrative work associated with the operation of the equipment.

At the Step 7, the stage of self-service begins as part of the teamwork of small groups. At this stage, the TPM system is being built. Then it develops as a current work.

Every employee should be aware of the losses, if it takes time to repair equipment. In addition, if the equipment cannot operate at full capacity or produces goods of poor quality, this is considered to be unprofitable. [9]

Seven steps to deploy self-maintenance equipment

1. Cleaning-checking - Complete equipment cleaning, removal of debris, dust and dirt, as well as lubrication and tightening bolts, detection and troubleshooting of equipment
2. Taking measures to eliminate pollution sources and hard-to-reach places - Converting pollution sources and ways to control the spread of pollution, as well as places that are difficult to clean and lubricate in order to shorten the duration of these processes
3. Development of temporary standards of cleaning-checking and lubrication - Development of temporary standards aimed at reducing the duration and maintaining the regularity of cleaning, lubricating and tightening bolts. (A time frame is needed for this work)

4. General verification - Training in equipment verification; detection and resolution of minor equipment problems during a general verification

5. Independent verification - Development and implementation of a checklist for operators to conduct independent inspections of equipment.

6. Standardization (supporting control) - Standardization of all types of inspections at the workplace and to achieve full systematization of the supporting control: standards for cleaning, lubrication, equipment testing; material consumption standards; standardization of data registration; standardization of control on equipment, tools, etc.

7. Self-management and self-organization - Modernization of equipment based on MTBF analysis (average time between equipment failures); elimination of irregularities in improving productive equipment maintenance.

The TPM starting point is that each employee is responsible for the daily maintenance of the equipment. Employees offer their methods for developing service. These are key functions in TPM. Taken jointly, they can increase the efficiency of the machine. Therefore, maintenance also means "improvement". After this, it is possible to identify and eliminate hidden defects in the machines.. [10]

VII. LOSSES DECREASING EFFICIENCY OF EQUIPMENT

Equipment is used in production as a means of obtaining value added. Work in production includes a number of problems that are accompanied by frequent changeover, wear, lack of a system of scheduled maintenance, etc.

There are six types of losses during equipment operation.

- 1 Breakdowns;
- 2 Many changeovers and adjustments;
- 3 Work at idle, premature suspensions;
- 4 Sharp decrease the speed;
- 5 Manufacturing defect;
- 6 Reducing the proportion of quality products

VIII. CONCLUSION

The TPM system allows improving the staff's attitude to the production equipment. This leads to a reduction in any production losses.

The equipment is improved every year and goes to a new level.

Attracting employees is important for short-term and long-term success. A powerful method of attracting employees is to create a common vision of the future "improved" state of the company. It is necessary to tell what benefits the employees will receive. This will create a strong motivation for success. Another powerful technique is the recognition and promotion of desired behavior. In the context of TPM, this may include providing a monthly trophy for the best area 5S or a gift certificate for the biggest Kaizen improvement.

Early success helps to gain long-term success by giving a pulse to this initiative. If an initiative is perceived as tested and failed, then in the future it will be much more difficult to successfully implement this initiative.

Demonstrating active leadership is one of the main responsibilities of senior management (up to the director) [11]

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