

TRAINING AND PRACTICE TO ENSURE IMPLEMENTATION OF THE TPM SYSTEM

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Applying the TPM system in practice is not only a technical and organisational matter. Equally significant and not to be overlooked is the process of education, training and practice (initial and continuous) for everyone who will be directly or indirectly engaged in the maintenance system based on TPM principles. Attention must be paid to the comprehensive and systematic provision of education in this area, especially in terms of the professions involved, the internal and external educational entities, and, last but not least, also in terms of resources allocated to technical and personnel costs. The article presents the concept of solving the process of educating entities involved in the process of maintenance management on the TPM principles. It connects internal and external educational subjects and proposes a process structured according to the level of management and professional orientation. It is intended for academics dealing with business processes as well as the management of new and established companies in which maintenance departments are established or restructured.

KEYWORDS

Totally productive maintenance (TPM), maintenance, education, training, practice, lecturer, implementation

1 COMPARISON OF THE TPM SYSTEM WITH A TRADITIONAL POST-FAILURE MAINTENANCE SYSTEM

Total Productive Maintenance (TPM) is an advanced method of rationally conceived maintenance: maintenance managed systematically, comprehensively, in a well-balanced way, and in compliance with the modern principles of management. Its aim is to achieve maximum effect with minimum consumption of costs.

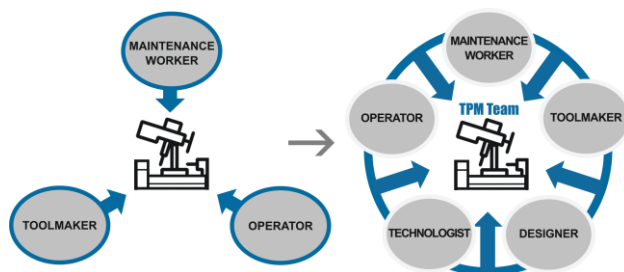


Figure 1. The traditional maintenance management system and the TPM system

The traditional maintenance management system, still primarily used in most enterprises, which is based predominantly on activities connected with eliminating failures and breakdowns, differs diametrically from the Total Productive Maintenance (TPM) system in many aspects. The

main differences consist in involving workers with a different number of specialisations and the level of cooperation, as shown in Figure 1.

The benefits of implementing TPM are also defined by differences between the cost structures of the two systems. In the case of the traditional approach, the main burden of costs is in the area of repairs (due to failures, operational accidents, and breakdowns) and in the area of production losses. The TPM system, however, focuses on preventative maintenance (i.e. planned maintenance supported by diagnostic maintenance) and also on the newly emphasised competency of the persons involved. The training and practice process for workers engaged in TPM team thus becomes absolutely essential, and a significant part of implementing and maintaining TPM. This phase is also a significant cost item of the TPM system, as shown in Figure 2.

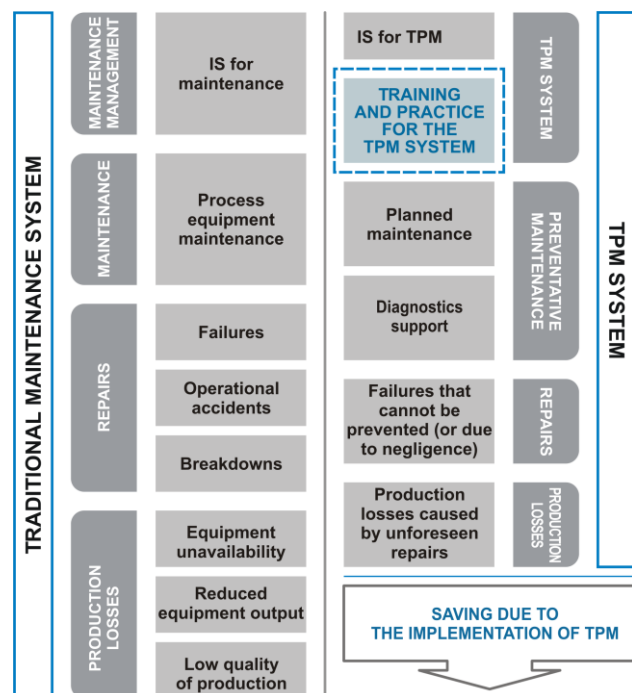


Figure 2. The cost structures of the traditional maintenance system and TPM

2 PERSONNEL SPECIALISATION FOR IMPLEMENTING TPM BASED ON FINDINGS FROM A PRODUCTION PROCESS ANALYSIS

A team led by doc. Ing. Josef Novák, CSc. at the Institute of Design, Management and Economics of Mechanical Production, Department of Mechanical Technology, Faculty of Mechanical Engineering, VSB – Technical University of Ostrava has experimented and conducted a study on the suitability of implementing TPM. This work examined the causes as well as the technological and economic impacts of failures and breakdowns. The failure rate over an extended period was studied on selected manufacturing equipment which was crucial within the technological process, and it was demonstrated that a maintenance system established on TPM principles was able to eliminate huge costs. [Necas 2013]

Although the study did not prove that the human factor played a significant role in the occurrence of failures and breakdowns, it did demonstrate that one unequivocal cause of such problems was the absence of any consistently carried out

preventative maintenance based on diagnostics and the principles of TPM.

These causes of technological process outages and consequent significant economic losses cannot be eliminated without measures to improve the knowledge and skills of workers and managers engaged in team cooperation within a system of total productive maintenance. The TPM training and practice process is thus a necessary condition if the corporate activity of maintenance is to function optimally. [Novak 2016]

3 CONCEPT OF TRAINING AND PRACTICE FOR WORKERS INVOLVED IN A TPM SYSTEM

The content of education within the TPM system covers two areas; firstly, it concerns the implementation and introduction of the system within the corporate management structure [Fusko 2018]:

- analysing the initial state;
- assessing the benefits of TPM on company effectiveness;
- creating TPM structures;

and secondly, it focuses on the long-term use and application of TPM principles to make corporate activity more effective [Kristak 2017]:

- monitoring the effectiveness of equipment (its availability, performance, and quality);
- application of autonomous maintenance (monitoring how the machines run);
- application of planned maintenance (depending on the period and age of machines, and according to diagnostics and instructions for maintenance and installation);
- using information systems for maintenance (recording and evaluating data); and
- continuous training, coaching, and management for TPM teams.

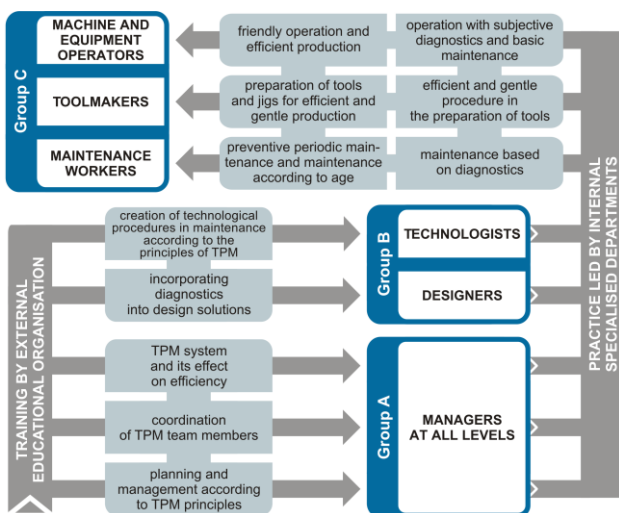


Figure 3. The education system for TPM managers and teams

A substantial number of employees are not familiar with the principles and functioning of the TPM system, and therefore any implementation and subsequent functioning of TPM will require the introduction of an education process. [Mosyurchak 2017] When doing so, it should be recognised that it is not only maintenance workers who need to have knowledge of how the

principles TPM operate – all positions involved in TPM teams must be included in the education process - see figure 3.

3.1 The emphasis of education on the process groups of TPN teams

Due to the involvement of a wider range of employees in various fields, specializations and organizational inclusion in the TPM process, it is necessary to focus the content of education for individual professional groups. With regard to the degree of complexity of the education system TPM groups should not be too many of, but it is necessary to differentiate learning management personnel preparatory phase processes, and executives associated with maintenance.

A. Management training (Group A)

The aim of familiarising all levels of management with the principles of TPM is to obtain information about the benefits of this system: in terms of eliminating losses by eliminating failures in production equipment; preventing a drop in output of the equipment; and, last but not least, eliminating losses arising as a result of reduced production quality. Knowledge obtained in this way should contribute to a better qualified decision to implement TPM into the process of maintenance work management.

Another aim of educating management in this area is to discover the rules for managing TPM teams so as to ensure optimum coordination of workers in all the relevant positions, and linking them together into cooperating work groups.

The TPM system also assumes a completely specific maintenance organisation, management and planning process, so training must also prepare management for these areas of activities.

Training for senior and middle management (company, plant and operations management):

- The decision-making process on the implementation of TPM approaches in the company and in operational practice.
- Selecting the departments and positions to be engaged and the extent of their engagement in the TPM system.
- Deciding on the resources intended for the TPM system.
- Influencing Overall Equipment Effectiveness (OEE) using the TPM system.

Training for lower management (supervisors as well as workshop and workplace managers):

- Ensuring conditions for changing the approach and providing motivation.
- Initiating and leading practice for the identification of abnormalities in the running of equipment.
- Ensuring the monitoring and inspection of production equipment, including their use.
- Creating standards.
- Monitoring the state of machines and their use.
- Interventions in the TPM system, if required.

B. Training for technical and economic workers – designers and technologists (Group B)

A maintenance management system based on TPM is closely related to how technical and economic workers perform their activities in design and production planning.

The structural design of products should reflect the optimum production process, and the technological processes should then ensure an appropriate level of labour productivity and stress on process equipment. The task of designer and technologist training must therefore be the implementation of these principles in activities that influence the production of products and operation of machinery. The training of technical and economic staff must therefore cover the four necessary thematic areas:

- The technical and economic preparation of investment projects in compliance with TPM system requirements.
- Preparing and conducting practical training for operators of production equipment.
- Reducing time losses of machinery and equipment (measurement of loss times, evaluation and feedback).
- Innovating and modifying equipment and machinery in compliance with TPM principles.

C. Practical training for machine and equipment operators, toolmakers, and maintenance workers (Group C)

The group of workers operating machinery and equipment, preparing tools and jigs and also carrying out maintenance must also all work as a cooperating team. Their activities must not only link up with one another, but also partially overlap.

Operators must not only carry out production process activities with the appropriate rate of productivity, but they must also carry them out in a sensitive and careful way that will not lead to excess machine wear. They should also have the ability to detect in time anomalies in the operation of equipment, and subjectively diagnose the need for a maintenance worker to intervene, or intervene themselves in the case of common or simple failures.

The maintenance department should focus its activities especially on the area of planned periodic maintenance according to the age of machines, and maintenance resulting from diagnostic data for the equipment and machinery. Capacity for maintenance workers to carry out these activities should be created owing to a decrease in the occurrence of failures and breakdowns, which should be achieved by the implementation of the TPM system.

Training for production equipment operators and service technicians (operators, toolmakers, and maintenance staff) should cover:

- The most frequent causes of failures and abnormalities in production equipment.
- The basic requirements for operators as the main subjects (actors) in the maintenance of machines.
- The division of competences between production, tool-shop and maintenance workers.
- Cooperation in an autonomous maintenance team.
- Defining standards in autonomous maintenance.
- Procedures for reporting and eliminating abnormalities.
- Organisation and competences in autonomous maintenance.

4 EDUCATIONAL ENTITIES AND VENUES FOR TMP TRAINING OR PRACTICE

The training and practice process in companies should not be based only on external educational institutions; rather, there should be cooperation between external and internal entities.

That is because both groups have different priorities, advantages and handicaps.

Whereas the theoretical basis for the implementation of a maintenance management system based on the principles of TPM is the prerogative of specialised scientific and research workplaces, and thus also of education and training institutions (e.g. universities and associated educational companies), the practical training for operators and maintenance workers should rely to a significant extent on internal managers and specialists who have received high-quality training, are managerially competent, and perfectly familiar with the relevant production process and specific machinery.

A two-level system for ensuring TPM teams have the right qualifications therefore presents itself: one level focuses on management and production planning specialists, while the second deals with equipment operators and maintenance workers.

External training companies lack sufficient specific knowledge of the corporate environment and thus have a tendency towards generalised solutions. On the other hand, they perfectly understand the implemented system, its rules and principles. Their role is therefore to ensure, by means of external courses, that teams have a correct understanding of and accept the rules of the TPM system and its activities, its implementation and maintenance.

In the second step, it is the role of management as well as technical and economic staff who have received high-quality training to train other workers within their company – machine and equipment operators, toolmakers, maintenance staff and other members of TPM teams – in operating machinery/equipment with due care, efficient production, subjective diagnostics, periodical maintenance, and the application of sets of detection methods when providing care for production equipment.

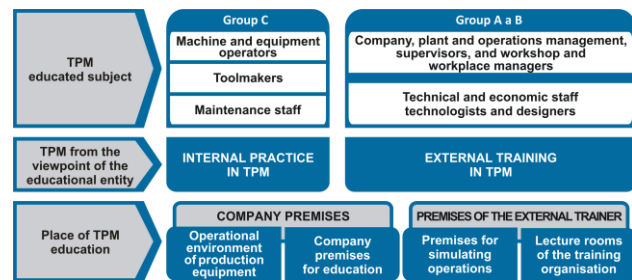


Figure 4. TPM team training and practice in terms of venue and participating subjects/entities

The division of the educational system for TPM according to the educational subject, the place of training and the subject implementation of the educated worker is comprehensively shown in Figure 4. Training of management and technical-economic workers should be suitably provided by external trainers in the company's premises or classrooms of educational institutions, while training of executive maintenance workers should be carried out more on their own and in the premises or operations of their own companies.

5 POSITION OF TRAINING AND PRACTICE IN THE COST STRUCTURE FOR IMPLEMENTING TPM

The provision of training and practice systems is not the most significant item in terms of the costs of implementing TPM. Costs must be seen in the following structure:

- **Time consumption of placing workers on TPM courses** – These demands are derived from the current use of workers in the production and administration process (e.g. processing orders) and the possibilities of eliminating these costs through effective organisation.
- **Costs of ensuring technical equipment for TPM courses** – They consist in the procurement, or rather use, of technical equipment for training activities which every company, even medium-sized ones, has at its disposal. Another possibility is the use of training and conference centres with high-quality equipment, or the capacities of universities (such as VSB – Technical University of Ostrava).
- **Costs of ensuring lecturers for TPM courses** – TPM courses are usually conducted by specialised companies that have experts in this area (training companies or universities, such as VSB – Technical University of Ostrava). Later on, the company's internally trained personnel can also be used. For those parts of courses with a technical focus, it is a good idea to involve employees of the companies supplying the relevant machinery and equipment.
- **Costs of ensuring materials for TPM courses** – These are the costs of consumables (paper, printer cartridges, etc.).

In terms of time, the training and practice system can be divided into a one-off TPM system implementation phase and a continuous training phase:

- **Training and practice in implementing the TPM system** – This assumes the training of all workers engaged in TPM teams, usually conducted by external specialists.
- **Continuous employee training system** (for new workers and workers newly engaged in the system) – These subsequent training cycles are usually provided by internal workers who have already completed the TPM training system – see part 3.

6 CONCLUSIONS

Education is an integral part of implementing the maintenance management process according to the principles of TPM, and has a significant impact on how such process will function. The article aims to provide guidance on how to conduct education and training of all employees involved in TPM systematically, consistently and thoughtfully, while the resources invested in this process must show the expected effectiveness.

It showed how to segment the professional groups involved in the management and realisation of TPM (or TIM) and clearly define their educational aims, the involvement of internal or external educational and training entities, and the venue as

well as the technical and material resources connected with realising this process. Only by adopting this approach can the implementation and subsequent application of the TPM system be properly provided for in terms of personnel.

The research question was therefore resolved by proposing a systemic concept for the education of TPM managers and teams, including securing this process and constructing a cost structure. The follow-up direction of research should focus on other areas associated with the implementation of totally productive maintenance in business practice.

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