

## **IMPLEMENTATION \$ RESULTS OF TOTAL PRODUCTIVE MAINTENANCE IN A SME**

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**Abstract** To Apply the TPM concept in a medium enterprise working in publishing industry, was a great challenge and an opportunity to verify the universality of procedures and the power of TPM to improve OEE indexes of the firm. The results of experiment can be used for re-organize the firm departments, and specially for improving the methods of monitoring, surveillance and control the machines and workers. The experimental results after one year of TPM practicing has undoubtedly shown that TPM is one of the most effective ways to reduce cycle time, to improve operational efficiency and to create a lean organization.

### **1. WHAT IS TPM**

A lot of scientifically papers, presented in different conferences all over the world, have already emphasized the importance of maintenance in manufacturing systems especially. For this reason, a large pallet of maintenance concepts, theoretically and practically training courses, guidelines and their application in connection with the basic rules etc. were conceived, tested and implemented. More recent publications [1], [2] emphasize the importance of an early consideration of maintainability and a systematic approach, and such because maintenance is related to safety, ergonomics and assembly.

A lot of books and scientifically articles addressing these topics already include suggestions and rules relevant to maintenance, generally speaking and to TMP in particular; this paper focuses on what is necessary for a general understanding and implementing of TPM concept and what are the benefits for a SME in a specific case.

Historically, TPM is an innovative Japanese concept derivative from *Preventive maintenance* in which the routine maintenance of equipment would be carried out by the operators, while maintenance department took up only essential maintenance works. Thus *preventive maintenance* along with *maintenance prevention* and *maintainability improvement* gave birth to **productive maintenance**. The aim of productive maintenance was to maximize plant and equipment effectiveness to achieve optimum life cycle cost of production equipment. Applying general rules of productive maintenance to all departments of the firm, offices included, the new concept has become Total Productive Maintenance. Nowadays, TPM is a manufacturing-led initiative that creates a collaborative approach among all stakeholders within an organization—particularly between operations and maintenance—in an effort to achieve production efficiency, uninterrupted operations and ensure a quick, proactive maintenance response to prevent equipment-specific problems

The TPM program uses in common with TQM some of the tools such as employee empowerment, benchmarking, documentation, etc. and also has some similar characteristics with it: total commitment to the program by upper level management, employees must be empowered to initiate corrective action, changes in employee mind-set toward their job responsibilities must take place as well, and a long range outlook must be accepted as TPM may take a year or more to implement and is an on-going process.

The main differences between TPM and other concepts are the following: the activities and measures are focused on inputs and causes for equipments, the required employees participation is hardware oriented and, the result of implementation must be elimination of losses and wastes in SME.

To describe briefly what is TPM concept and for what is it good for, in figure 1 are shown some important characteristics which define the TPM as useful for maintaining plants and equipment.

Motives of TPM	Adoption of life cycle approach for improving the overall performance of production equipment. Improving productivity by highly motivated workers which is achieved by job enlargement. The use of voluntary small group activities for identifying the cause of failure, possible plant and equipment modifications.
Uniqueness of TPM	The major difference between TPM and other concepts is that the operators are also made to involve in the maintenance process. The concept of " <i>I (Production operators) Operate, You (Maintenance department) fix</i> " is not followed.
TPM Objectives	Achieve Zero Defects, Zero Breakdown and Zero accidents in all functional areas of the organization. Involve people in all levels of organization. Form different teams to reduce defects and Self Maintenance.
Direct benefits of TPM	Increase productivity and OPE ( Overall Plant Efficiency ) by 1.5 or 2 times. Rectify customer complaints. Reduce the manufacturing cost by 30%. Satisfy the customers' needs by 100 % (Delivering the right quantity at the right time, in the required quality.) Reduce accidents. Follow pollution control measures.
Indirect benefits of TPM	Higher confidence level among the employees. Keep the work place clean, neat and attractive. Favorable change in the attitude of the operators. Achieve goals by working as team. Horizontal deployment of a new concept in all areas of the organization. Share knowledge and experience. The workers get a feeling of owning the machine.

**Fig. 1. TPM characteristics and targets**

## **2. IMPLEMENTATION OF TPM IN AN ORGANIZATION**

### **2.1 The main coordinate**

For TPM implementation there are four tool cornerstones which should be followed:

1. Overall Equipment Effectiveness (OEE) - a tool that combines multiple manufacturing issues and data points to provide information about the process. It is an all-inclusive benchmarking tool that serves to gauge the various sub-components of the manufacturing process (availability, performance, quality etc.) and used to measure actual improvements on implementation, in such a way that the benefits become tangible and noteworthy.

As to the main management analyse the index considered was the follows:

- Ivy-Inventory;

- Wmp-Work in machining process;
- Mte-Machine tool efficiency;
- Lpt-Lead time order to product;
- Mst-Machine tool set time;
- Mlt-Manufacturing lead time;
- Ert-Equipment running time;
- Tsm-Time of materials cycle;
- Cpw-Cost of product warranty;
- Cdi-Cost of direct & indirect labor;
- Pcs-Product cost;
- Opc-Overall productivity of entire capital

The good thing about using OEE indexes is that this particular measuring tool cannot be manipulated and supply most effective benchmarking tool in making sound management decisions.

2. 5S – complex of activities which helps cleaning and organizing the workplace for making problems visible: Sort, Systematise, Sweep, Standardise, Self - Discipline.

3. **Kaizen** - a systematic way to make “continuous improvement” – slow but constant.

4. Autonomous maintenance (AM) – a method to select the task of maintenance which is suitable to be transferred to operators.

Checking in a normal plant all maintenance jobs, a mixture of the following type of activities will be finding: emergency repairs, inspections, lubrication, oil changes, adjustments, conditions checks, planned replacements, modifications, reconditioning, etc. Research has shown that about 60 percent of the jobs on the list could be considered simple. This means that only basic maintenance knowledge is required and there are no safety risks involved. These 60 percent represent only about 20 percent of the time for the maintenance personnel, as they are quick and simple by nature, but a transfer of these duties to operators would nevertheless be a great relief for the maintenance department.

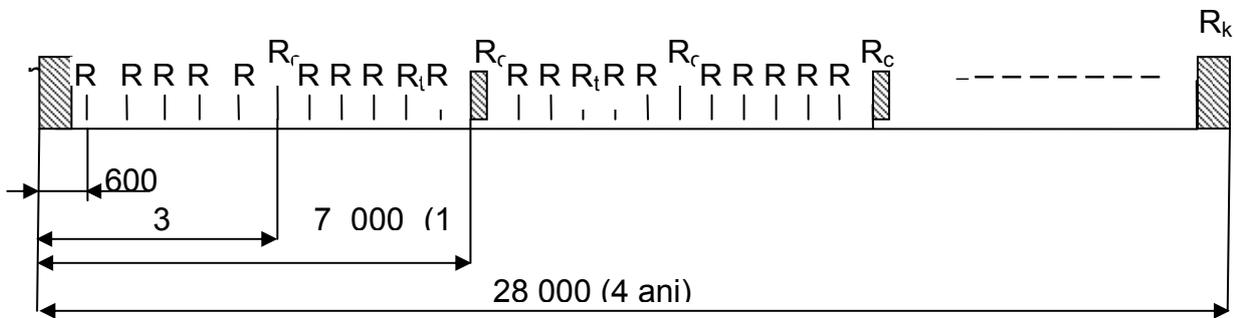
To determine the simple maintenance jobs which can be transferred to operators, an across-functional teamwork that is carried out by technicians, operators, engineers and supervisors must be make up. The idea is to go to the shop-floor with all the knowledge we have about the machinery, discuss it together, and then list everything that is needed on a specific equipment to ensure it is run problem-free. This includes cleaning, inspections, preventive maintenance, checks, etc.

This list is useful to determine what is suitable or not for the operators. The key to successful implementation of AM is that operators should participate in the maintenance, but that the work should not have a negative effect on their normal duties. The tasks that are not considered suitable for AM are transferred to the preventive maintenance schedule and will be carried out by the maintenance department or by specialists (e.g. in figure 1 and 2 is shown the repair cycle for two equipment from a SME working in publishing industry) a and in figure 2

Useful for some OEE indexes calculation and for selecting the autonomous maintenance tasks in the shop-floor is the list with all SME equipment, conceived as is shown in Tab.1

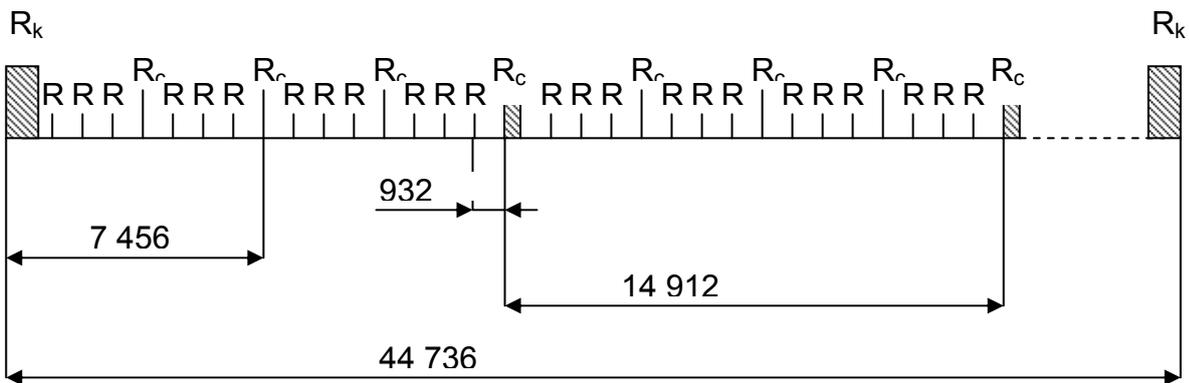
The next step, which is very important, is training of the operators. The training is typically executed by the maintenance department in a TPM organization. The operators should individually determine their need for training. The training should be hands-on and on-the-job with a good possibility to practice.

Repair Cycle Cod: **3.3.40**



**Fig. 2 Preventive maintenance cycle for a Reciprocating compressor**

Repair Cycle Cod: **2.9.36**



**Fig. 3 Preventive maintenance cycle for a Printing Machine "Gazelle"**

**Tab. 1 Equipment List**

Nr. Crt.	Equipment	Go in data	Inventory number	Acquisition amount		Replacement amount		n – new o-old
				[Lei]	[Euro]	[Lei]	[Euro]	
1								
TOTAL								

It is important to have a good system for scheduling and follow-up of the TPM duties, but, even in the SME there is a computer system for manufacturing management (CMMS), is better to use check-lists or card systems (e.g. in figure 4) to implement a scheduling system for TPM because the operators do not use the computer system daily.

**Time card**  
**Month...May ...Year...2009...**

Day	Active work hour/shiftwork			T.R. [h]	Outage time (T <sub>o</sub> ) [h]							Lying downtime (T <sub>l</sub> ) [h]	
	I	II	III		Total (T <sub>o</sub> )	S	Sl	M	E	O	X	Scheduled	Performed
0	1	2	3	4	5	6	7	8	9	10	11	12	13
1	0			0	0	1	0	1	0	0	0	8	8
2	0			0	0	1	0	1	0	0	0	6	4
3	0			0	0	1	0	1	0	0	0	1	0
4	9			21	1	13	0	1	0	0	0	1	0
5	0			0	0	1	0	1	0	0	0	1	0
6	4			24	4	1	4	1	0	0	0	1	0
30	5			24	3	1	0	1	0	0	3	1	0
31	0			0	0	1	0	1	0	0	0	4	2
<b>Total</b>	<b>122</b>	<b>0</b>	<b>0</b>	<b>552</b>	<b>62</b>	<b>1</b>	<b>16</b>	<b>14.5</b>	<b>4</b>	<b>6.5</b>	<b>20</b>	<b>26</b>	<b>242</b>

Legend: T.R. – Total real time in a day; S – Shutdown; Sl – Scarcity of labor; M – Material fail; E – Energy shortage; O – Order lack; X- Other causes

Registered personnel  
 .....

Supervisor  
 .....

**Fig. 4 Individual Time card for an equipment**

**2.2 Stages and steps followed**

**A - Preparatory Stage:**

STEP 1 - Announcement by Management to all about TPM introduction in the organization, prepare awareness programs by senior management, publish it in the house magazine and put it in the notice board, send a letter to all suppliers and distributors.

STEP 2 - Initial education and propaganda for TPM done to employees involved.

STEP 3 - Setting up TPM and departmental committees which should take care of all needs: improvement, autonomous maintenance, quality maintenance etc.,

STEP 4 - Establishing the TPM working system and fix up the target for achievement.

STEP 5 - Conceive a plan for institutionalizing the TPM as an organizational culture.

**B - Introduction Stage**

During a ceremony, at which all suppliers, vendors, customers, related companies and affiliated companies was invited, the implementation of TPM in firm was announced.

**C – Implementation Stage**

In this stage eight activities are carried which are called eight pillars in the development of TPM activity. Of these four activities are for establishing the system for production efficiency, one for initial control system of new products and equipment, one for improving the efficiency of administration and one for control of safety, sanitation in working environment.

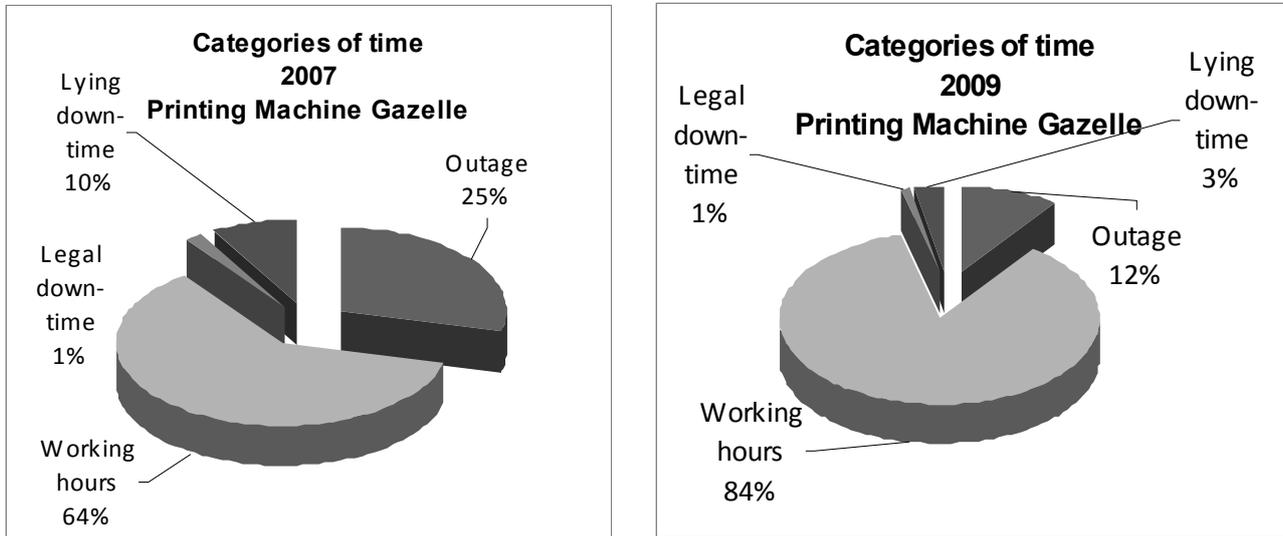
**D - Institutionalizing Stage**

After one year the TPM has becoming a part of SME culture and the workers use all procedures in a natural way.

**3. PRACTICAL RESULTS OF TPM IMPLEMENTATION**

The results after one year of practice in TPM implementation are presented in comparison with the initial state of art in the figures 5, related to a single equipment of the publishing shop floor. At a glance it is obvious that the Printing machine Gazelle is now more efficient and more reliable. The answers to other questions like: is the machine operating at full

capacity, is the maintenance cost chipper, the outage causes are well known and predictive, the workers are well trained to optimum operate the machine and so on, does not result directly from the experimental data but they could be fined by analyzing the products and also the entire printing process in firm.



**Fig. 5 Time categories for printing equipment**

#### **4 CONCLUSION**

Modernization and the ongoing automation in different industries have noticeably amplified the gap between operators and their machines. Years ago, machine operators were limited to manning their respective posts. Whenever there is a mechanical trouble, operators would stop working and would call in the mechanics to fix the problem. The mechanics know that they have become indispensable specialists in the trade. But with the adoption and adaptation of TPM, the vicious cycle has come to an end. Coupled with the right tools and training, TPM equips the operators the necessary skills to address mechanical or equipment-related issues. Calling the engineers and mechanics is no longer necessary since operators are already prepared and confident in dealing with problems.

The results of experiment can be used for re-organize the firm departments, the materials and data flow and specially for improving the methods of monitoring, surveillance and control machines and workers. An experiment based on manufacturing costs fulfilled at the same firm has undoubtedly shown that TPM is one of the most effective ways to create a lean organization with reduced cycle time and improved operational efficiency.

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