**IDEA GROUP PUBLISHING**
701 E. Chocolate Avenue, Suite 200, Hershey PA 17033-1240, USA
Tel: 717/533-8845; Fax 717/533-8661; URL-http://www.idea-group.com
**ITB12765**

This paper appears in the book, *Emerging Trends and Challenges in Information Technology Management, Volume 1 and Volume 2* edited by Mehdi Khosrow-Pour © 2006, Idea Group Inc.

# A TPM Toolset for Small and Medium-Sized Businesses

Axel C. Schwickert, University of Giessen, Germany, Licher Str. 70, D-35394 Giessen, Germany,
P +49-641-99-22-611, F +49-641-99-22-619, axel.schwickert@wirtschaft.uno-giessen.de

Bernhard Ostheimer, University of Giessen, Germany, Licher Str. 70, D-35394 Giessen, Germany,
P +49-641-99-22-611, F +49-641-99-22-619, bernhard.ostheimer@wirtschaft.uni-giessen.de

## TOTAL PRODUCTIVE MANAGEMENT (TPM) AND KAIZEN

In 1937, the Toyoda family founded the "Toyota Motor Company" in Japan and chiefly constructed lorries for the military government. In 1949 a long strike led to a considerable slump in sales – urgent measures were required in order to save the company from going under.

The Toyota employee, Taiichi Ohno, studied the production style at Ford in North America and came to the conclusion that this kind of mass production with a strict division of labor was not viable for Japan. Another way would have to be found in order to make the Japanese automotive industry competitive worldwide. Back in Japan, Ohno experimented with partly autonomous production streams, where employees were personally responsible for tasks ranging from cleaning, maintaining and carrying out minor repairs on machines through to the improvement of work processes, alongside their production tasks. So that each employee could contribute towards improving his working environment, Ohno planned times, activities and coordination mechanisms accompanying the production processes especially for this purpose. In this way, numerous small defects could also be identified as they arose and immediately eliminated. Contrary to the Taylor production system at Ford, where quality control was carried out on the products at the end of the production process, Toyota emphasized the importance of an ongoing quality control of the production processes. The fundamental idea was that a production process with no defects would result in high quality products and satisfied customers. Moreover, the company's economic success would also be boosted in the process, due to the fact that any waste (Jap. Muda) could be eliminated from the production processes e.g. overproduction, bottlenecks, unnecessary transport and poorly adapted work processes.

Zero-defect and no-waste production processes constitute the cornerstones of the Toyota Production System (TPS) which has been known as "lean production" worldwide since the 80s. Working towards these ideal standards involves a "continuous improvement process" (CIP), Jap. Kaizen. Today, Kaizen is based on establishing, maintaining and improving standards and eliminating waste. Kaizen does not proceed in leaps forward or changes in categories, but is implemented continuously in small steps. At its roots Kaizen is not so much a concrete plan of action but more a basic approach which has to be adopted by all the partipipants in the company on a daily basis. (Teufel 2003, p. 505)

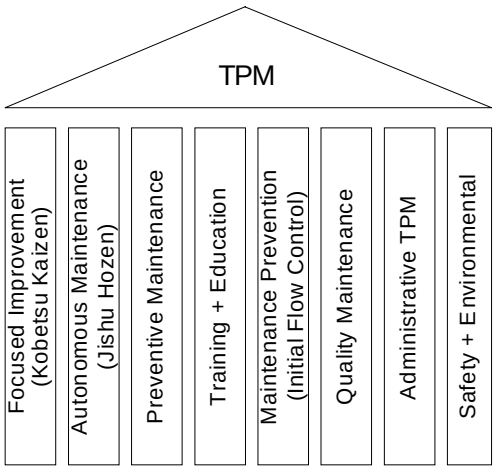
The Kaizen philosophy includes a multitude of independant methods and instruments such as just-in-time, value stream design, total quality management, total flow managment, process mapping, total productive management (TPM) and others. Originally TPM was defined as "total productive maintenance" and was exclusively concerned with the maintenance of machines and facilities. Today TPM is understood as total productive management, i.e. a holistic structured program for the sustainable elimination of all the defects and losses in the production and administration processes of a business (Al-Radhi 2002, p. 5 and Willmott 1994, p. 2 and Hartmann 1992, p. 15).

TPM within the framework of the "Kaizen management system" can be understood as an all-embracing program for the sustainable improvement of all areas of the company. The eight pillars of TPM in fig. 1 (according to the Nakajima model, Nakajima 1988) clearly illustrate the program-like character of TPM. Each of the pillars describes a distinct TPM sphere of activity, which can be inspected and optimized using defined tools. The eight pillars show that the application of TPM has extended beyond the production and maintenance areas of the company to areas ranging from organisational processes, office areas, work safety, health and environment protection through to the development of new products and processes. TPM has thus taken over an increasingly dominant role within the Kaizen philosophy (Leikep 2004).

The practical implementation of TPM in a specific production area of a company starts off with the analysis of the processes in the area concerned. As a rule, information on the processes is collected by systematic audits of the area. These audits are held in so-called "Kaizen workshops". For the initial introduction of TPM in a certain production area, often a 5S workshop is carried out which focuses on small steps, for example the cleanliness and orderliness of the production area concerned: Seiri (organization), Sieton (orderliness), Seiso (cleanliness), Seiketsu (standardized clean-up), Shitsuke (discipline). (Willmott 1994, p. 13, 48, 49 and productivity 1999, p. 1-10)

Besides identifying and documenting defects and losses, the workshops also encourage the standardization of the related countermeaures and the continuing permanent monitoring of the areas concerned. By carrying out the basic workshops such as, for example, 5S, the area of the company can reach and maintain certain standards of quality, which the ensuing workshops can build upon. At the same time, the acquired Kaizen

*Figure 1. The eight pillars of TPM*



pattern of behavior can extend throughout the business to other processes. The company thus "learns" the Kaizen philosophy step-by-step by practising TPM and and reaches successively higher TPM levels of maturity.

The mistakes, losses and defects identified in the course of a TPM process analysis largely result from organizational and operational problems with the production plants and procedures, for example as regards orderliness, cleanliness, safety, modes of operation or process efficiency. These causes of the problems can be fundamentally and permanently resolved with standardized solutions. In modern TPM, the identification, description and analysis of problems is therefore of essential importance. Yet the quantity of problems should not be underestimated. Experience from a multitude of consultancy projects has shown that in businesses introducing TPM several hundred problems are identified in the first workshops.

The systematic recording, documentation, analysis and control of these problems is a considerable challenge, in particular for small and medium-sized businesses implementing TPM as all-embracing management system. This challenge is reinforced by continuing globalization and the decentralization of small and medium-sized businesses (Kemp et al. 2004, p. 2). In organizational structures that are increasingly dispersed, systematic management, a structured overview and effectively solving a large number of problems is a complex task. Each problem is documented and stored so that it can be reproduced: its geographical and personal localization, its facts, its description, its countermeasures, its deadlines. Storage of data on the problems must make it possible to analyze either all the problems of the business as a whole, or parts of them in a structured manner. The documentation and analysis takes place in Kaizen terminology in a so-called "PDCA problem store". PDCA stands for "Plan – Do – Check –Act" (the Deming circle according to W. Edwards Deming, Ho el al. 1998 and Imai 1994, p. 32). It expresses the general approach towards handling problems, according to which each solution to a problem must be planned, started, checked and implemented. Suitable IT support must be created in order to meet these requirements with the principle "keep it small and simple!" due to the limited resources of small and medium-sized businesses.

## REQUIREMENTS FOR A TPM TOOLSET IN SMALL AND MEDIUM-SIZED BUSINESSES

In order to exploit site advantages, small and medium-sized production companies are always spread out in various international locations. This geographical spread brings about a spread in organizational structures and functional processes. Big companies are used to this spread in structures and perform their planning and control tasks using group-wide distributed computing solutions based on high-performance commercial database and middleware systems. The acquisition of solutions of this kind is too expensive for small and medium-sized businesses and most companies do not have the requisite personnel and financial IT resources for their ongoing operation.

For small and medium-sized businesses it makes sense to carry out TPM problem management with a web application on the basis of standardized system building blocks in the Internet (e.g. a LAMP system). A web application of this kind is built upon a central database, which can be used at all sites of a company via a uniform and multi-lingual web interface with a standard browser. The following section gives details on the conceptional structure of a web application of this kind which acts as "TPM toolset".

### Conceptional Structure of the TPM Toolset

A web application for TPM problem management must fulfill a series of basic requirements in order to correspond with the geographical, organizational and functional spread of a business.

- **Networked by the Internet.** The TPM toolset is installed centrally on one single web server for the entire company, even if it is spread out internationally, and can be used by all parts of the company.
- **Standard web server internet.** The TPM toolset server is a standardized web server which can be installed and operated quickly and easily without specialist know-how .
- **Standard browser on the user PC.** The user's PC does not require the installation and maintenance of any special software. Each user can use the TPM toolset alone with a standard web browser.
- **Zero-maintenance user PC.** The web browser on the user's PC does not as a rule require maintenance of any kind.
- **Stable "indestructible" interface.** The TPM toolset can not be brought to a standstill by faulty operation. The TPM toolset helps the user avoid faulty operation.
- **Quick and lean operation.** The TPM also runs effectively on "old PCs".
- **Each to their own in the TPM toolset.** The TPM toolset shows each user only the exact data required for his tasks.
- **Multi-user capacity.** An unlimited number of users can work in the TPM toolset without colliding.
- **Multi-lingual capacity.** An unlimited number of languages can be installed in the toolset for the user interface.
- **Roles concept.** Depending on their role in the Kaizen procedure, the users of the TPM toolset are given various types of authorization. There are different roles such as Kaizen trainers, Kaizen controllers, Kaizen implementers and administrators.

### Introduction of the TPM Toolset

First of all, the Kaizen program must be accepted by the company and introduced with the support of somebody experienced (mainly external consultants). Building upon this, the introduction of the TPM toolset can be started, where the TPM toolset administrator is responsible for the initial installation of the TPM toolset so that the controller, trainer and implementer can use the TPM toolset for the recording and monitoring of problems. The intitial installation of the TPM toolset consists primarily of entering the master data (standard / default values) and giving authorization for use to the controller, trainer and possibly other administrators. We suggest the following steps for the initial installation of the TPM toolset:

- **Collect the location of problems (organizational structure) in the company.** The administrator records the organizational structure of the company and its subsidiaries (divisions etc.), factories (branches etc.), areas (halls, assembly lines etc.) and objects (machines, places etc.) where there are problems to be solved.
- **Enter master data (standard / default values).** The administrator records the Muda types (types of waste), standardized countermeasures, red point reasons, departments responsible for implementation and workshops that should be offered to the trainers and controllers in order to use the TPM toolset as default values.
- **Enter the TPM toolset users and their authorization.** The administrator records the various persons who will be using the TPM toolset. Each person is assigned one or several locations in the company. Each person is given a login user name and a personal password. Each person is assigned a certain role (implementer, trainer, controller, administrator) in the TPM toolset together with authorization to use the TPM toolset in their role in defined locations in the company.

### Operation of the TPM Toolset

Kaizen workshops are carried out during operation. These Kaizen workshops comprise Kaizen audits. In a Kaizen audit the participants identify a series of problems related to objects (e.g. machines, workplaces). These problems must be documented in writing and with a picture and included in the TPM toolset. The following information must be entered for each problem:

- Problem-solving measures,
- Person implementing the measures,

- Costs of problem-solving and benefit that can be generated from the solved problem,
- Start and finish dates with the target status and actual status of the PDCA phases for problem-solving,
- Status of the problem-solving.

During the operation of the TPM toolset, the authorized persons fulfill their roles in their locations. One person can have several roles.

- Trainers document problems and distribute the problem-solving measures to the implementers.
- The implementers are responsible for carrying out the problem-solving measures.
- The controllers supervise and manage the execution of the problem-solving measures with economic figures.
- The administrators maintain and take care of the configuration of the TPM toolset in the company.

The various roles require various functionalities of the TPM toolset in order to carry out their tasks.

### Trainer Functionalities in the TPM Toolset

The way in which the TPM toolset functions for a trainer is that it assumes that the trainer takes care of a problem, documents it and supervises the solution directly at the machine or workplace or elsewhere (at the object of reference). The trainer works in a specific area of his plant and can be responsible for several problems in this area. A trainer must therefore be able to document and work on "his problems" quickly and easily at all times. The trainer mainly needs the following functionalities for this task:

- **Manage problem data.** The trainer sees, records and maintains all the data on "his" individual problems.
- **Problem statistics.** The trainer receives a general tabular overview of "his" problems with the most important aggregated problem figures.
- **Problem schedule.** The trainer receives an interactive time bar chart with "his" problems (completed, ongoing, pending), providing him with his own personal overview and facilitating time planning.

### Implementer Functionalities in the TPM Toolset

The way in which the TPM toolset functions for an implementer is that it assumes that a trainer assigns each of his implementers one or more specific measures (actions) to solve a problem (on a machine, workplace or other) in the TPM toolset. In addition, the implementers are given the start and finish deadlines for each measure. An implementer must be able inspect "his problems" with the measures to be implemented (actions) and deadlines quickly and easily at all times. This inspection can take place at his computer, after having entered the implementer login in the TPM toolset. The implementer should also be able to print out an up-to-date problem/measure plan (action plan) at all times, so that he can be informed on his tasks and deadlines, independently of his computer workplace. When the implementer has completed a problem-solving measure, he reports this to the trainer, who enters the relevant data into the problem store of the TPM toolset. The implementer should be able to refer to the TPM toolset and access the problem data that is relevant for him personally.

### Controller Functionalities in the TPM Toolset

The way in which the TPM toolset functions for a controller is that it assumes that the controller has to supervise and manage a large number of problems (and trainers) within a plant, a subsidiary or an entire company hierarchy. The controller is therefore not primarily occupied with the operational solving of the problems (this is the role of the trainers), but with scheduling, objective control, prioritization and escalation processes. The controller must therefore be able to receive effective overviews of the major "green and red" problem areas, produce effectiveness and efficiency figures/charts and activate the monitoring of processes quickly, easily and all times.

Individual controllers therefore supervise and manage entire problem areas. Each controller can be allocated a specific part of the company – the controller can only "see" and "supervise" these parts. The TPM toolset therefore makes it possible to set up controlling hierarchies with area, plant, subsidiary or company controllers, who are allocated major parts of the company. The controller needs the following functionalities for these tasks:

- **Problem store.** The controller sees and monitors all the data on "his" individual problems in a tabular general overview with the most important aggregated problem figures.
- **Problem scheduler.** For his personal overview, the controller receives an interactive time bar chart with the problems for which he is responsible.
- **Confidence curve.** The controller receives a graphical and tabular analysis of the problems that have been treated and those that are in process in his area of responsibility together with the computed completion quota.
- **Red Points.** The controller receives a graphical and tabular analysis of the problems with and without red points in his area of responsibility.
- **Muda distribution.** The controller receives a graphical and tabular analysis of the Muda types of the problems in his area of responsibility together with computed percentage values.
- **Cost/benefit.** The controller receives a graphical and tabular analysis of the costs and benefits of the problems (countermeasures) in his area of responsibility.

## CONCLUSION

The management of problems and measures to solve the problems that are identified within the context of TPM and Kaizen, is a difficult task, above all for small and medium-sized businesses. The bigger the spread of the organizational structure of the business, the more difficult it is to obtain a systematic and structured overview. In particular, the time and location-related aggregation for data analysis and figures (e.g. the confidence curve depicting the relationship between cumulated completed and cumulated ongoing problem-solving measures) is not feasible without suitable IT support.

The TPM toolset must be designed for application in multi-layer company hierarchies. The introduction of the TPM toolset does not have to be implemented in the entire company and all layers of hierarchy, but can be implemented step-by-step "from the bottom upwards". In this way, the company can use the TPM toolset for individual objects and areas in a plant or for all areas of the entire plant.

Once the TPM toolset has proved successful in the part of the company where it was first implemented, the application can be extended to higher levels of hierarchy. The TPM can, at all times, be extended to as many subsidiaries, plants, areas and departments as required throughout the breadth of the hierarchy structure. The geographical sites where the TPM toolset server or where the application areas of the TPM toolset are located are of no importance.

The extension of the TPM toolset application areas to several parts of the business provides the controllers at central locations in the business with a significant range of control over the problems, solutions to the problems and the relevant deadlines and objectives that have been set. Prioritization and escalation processes in, for example, several factories can also be monitored centrally by the controllers. The TPM toolset should be able to assign responsibility for the controlling of selected plants, areas or individual departments to specific (groups of) persons. In the TPM toolset the controlling tasks and authorization can be allocated in accordance with the company's usual relationships of subordination.

This scaling concept thus ensures that the TPM toolset can be implemented both in small businesses with only one production unit and middle-sized businesses with several geographically dispersed sites. The

range in hierarchy of the TPM toolset can, if required, be extended at all times and grow step-by-step with the extension of the Kaizen measures in the company.

## REFERENCES


AL-RADHI, MEHDI, 2002. *Total Productive Management*. Munich: Carl Hanser Verlag.

HESS, M., 1995. TQM/Kaizen – Praxisbuch – Qualitätszirkel und verwandte Gruppen im Total Quality Management. Cologne: Tuev-Verlag.

HARTMANN, E., 1992. *Successfully Installing TPM in a Non-Japanese Plant*. Pittsburgh: TPMPress.

HO, S. AND FUNG, C. K. K., 1998. *TQM EXcellence Model*, viewed 20 September, 2005, <http://www.hkbu.edu.hk /~samho/ tqm/tqmex/ content.htm>

HOWREN, M., 1999. *Implementing CANDOS to Change the Culture and Prepare for Autonomous Maintenance*. 10th Total Productive Maintenance Conference, Las Vegas: Productivity.

IMAI, M., 1994. Kaizen – Der Schlüssel zum Erfolg der Japaner im Wettbewerb.4th ed. Berlin: Ullstein Verlag.

KEMP, J.L.C. AND STURM, F. AND PUDLATZ, M. AND WAGNER, F. AND HARRIS, H. AND LEFÈBVRE, L.-A. AND LEFÈBVRE, E. AND NOE, P., 2004. *An integrated set of methods and tools for strategic management of knowledge-based, adaptive SMEs*, viewed 10 September, 2005, <http:// www. symphony-village. com / images/ IMSForum04_Symphony _Strategy _ May %202004.pdf >

LEIKEP; S., 2004. *TPM als Produktionssystem: Vom Instandhaltungstool zum umfassenden Managementansatz*, viewed 8 September, 2005, <http://www.competence-site.de/instand haltung .nsf/ 3447546C76DD16A7C1256FEA00513FF3/$File/ tpm_frauleikep_ 2005.pdf>

NAKAJIMA, S., 1988. *Introduction to Total Productive Maintenance*. Cambridge, MA, Productivity Press.

PRODUCTIVITY, I., 1999. *5S for TPM - Supporting and Maintaining Total Productive Maintenance: Participant Guide*. Portland: Productivity.

ROBINSON, C. J. AND GINDER, A. P., 1995. *Implementing TPM: The North American Experience*. Portland: Productivity.

TEUFEL, P., 2003. ´Der Prozeß der ständigen Verbesserung (Kaizen) und dessen Einführung´, in BULLINGER, H.-J. AND WARNECKE, H. J. AND WESTKÄMPER, E. (eds.), *Neue Organisationsformen in Unternehmen*. 2nd revised and extended ed. Berlin/Heidelberg/New York: Springer.

WILLMOTT, P., 1994. *Total Productive Maintenance: The Western Way*. Oxford: Butterworth-Heinemann.