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Preventive maintenance is an enabler for operation excellence in support processes

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Abstract

Purpose – The purpose of the paper is to analyse and determine how Total Productive Maintenance (TPM) can be applied within the support process as well as to identify possible effects from an employee and business perspective.

Design/method/approach – A qualitative research approach was selected. Empirical data was gathered using semi-structured interviews at one case company, but from several teams, that had applied preventive maintenance. The result was then used to extrapolate how TPM can be applied in a support process as well as to identify business and employee effects.

F**indings** – TPM in a Lean office environment can create values both in a business and an employee dimension. In the employee dimension TPM reduces the risk of missing/forgetting areas of responsibility and creates more involvement. In the business dimension objectives such as cost, quality and supporting the reduction of waste improved.

Preventive maintenance meetings can be included and performed once a month in the ordinary departmental "stand-up meetings". Methods like 5S, which need to be updated on a continuous basis, and standardized maintenance should also be connected to the TPM work. But first all employees should be trained in order to have the same direction/behavior.

Originality/value – The paper gives practitioners a perspective on how TPM can be applied within the administrative processes in a production company.

Keywords –Lean office, total preventive maintenance, support process, service management

Article type – Case study

Introduction

Suppose a typical case example from a production company in a common department X. During the upcoming week there is a planned visit from a customer. The first thing to do for an employee is to give a presentation with basic information of the company, after that a site tour is planned. The employee responsible for the visit starts with at least one hour preparation before that. He searches for the latest existing presentations, often in his own computer or the intranet or by asking some colleagues for the latest version. Often it can be found on the intranet web, but he does not now who is responsible, and is the content up-to-date? After finding the version the employee starts to verify and check the presentation, whether it is the latest one and if it is up-to-date. After some work, he saves the presentation on his own computer; now finally after some hour's preparation he is ready for the visiting customer.

Suppose now another typical case example in the same company but in another department Y at the same time and in the same production site as in the case of department X. There is a planned visit from a customer; the procedure is the same as above. After the employee finds the right version he starts to verify and check the presentation, check if it is the latest one and if it is up-to-date. After some work, he saves the presentation on his own computer or in the web intranet, now finally after at least one hour he is ready for the visiting customer.

These situations are often common and present in most companies today, thus work tasks that constitute extra work that should not be needed. This extra work is often not visible.

In order to stay competitive in today's marketplace it is vital to reduce activities that do not create value. Lean production has in the last decade been seen as mean to reduce non-value-time and there have also been some documented improvements in administration processes using lean production. The office environment often presents a major improvement opportunity to reduce necessary activities (Hyer and Wemmerlov,, 2002, Tiplady 2010). Lean is about reduction of waste and to focus on what is value from a customer perspective in order to improve the processes and business (Hines et al., 2004). Lean contributes positively to business performance applied in a manufacturing context and is also suggested to do the same in a service context (Bicheno, 2008; Hallgren and Olhager, 2009; Narasimhan et al., 2006).

The two employees in the case above explain the experience during the journey to prepare for the visit, which causes several different problems and situations requiring extra work, due to undefined ways of working and not updated and maintained material. It is also not a common way to share improvements. In these examples the employees face all three parts of Lean's three M, Muda (waste), Muri (overload) and Mura (unevenness) (Bicheno, 2004).

In a production context many companies has worked to master these 3 M for creating better production systems, while outside the production context the progress is not at the same level. There, as in the service sector, processes must be managed more like in production lines,

using Lean principles and methods as standard work and visual management, according to Allway and Corbett (2002). The work to create an efficient system, i.e. reduce variation, overload and waste, is as important as in the production. Moreover, in a service context the office environment is likely the area with the highest level of waste (Bicheno, 2008).

Two main methods, 5S and total productive maintenance (TPM), are useful in Lean in order to minimize wastes as unplanned stops, reduce variation for unplanned work and create plans to avoid overload (Pettersen, 2009). The use of TPM in a production context is described positively from both a method perspective and a business improvement perspective in existing research (Ahjua and Khamba, 2008; McKone et al., 1999). Maintenance can improve up to 40% of the non-value adding time in the production (Ahuja and Khamba, 2008), which also should make it obvious to create a suitable maintenance strategy for administration processes and integrate it into the business strategy. Thus this strategy should be related to all company functions to ensure a valuable aid (Crespo et al., 2009). Regarding how to apply TPM ideas in administration processes, there is not much previous research. Ideas from 5S have been transferred into the office environment in connection to the physical work environment. Lean ideas have been applied in this context to structure according to standards and clean desk policies (Knight and Haslam, 2010). Literature on classification of maintenance management has so far been very limited (Garg and Deshmukh, 2006) and TPM has only aimed at increasing the effectiveness of production, but not in an office environment (Kot and Grondys, 2013).

This presentation argues a need for work tasks that should be standardized and visualized and have a maintenance schedule connected to them. This poses a possibility to analyze how and if Lean methods, such as TPM including 5S and visualization, can support and improve support processes in companies by standardization. Hence the purpose of this paper is twofold:

To analyze and determine how TPM can be applied within the support process as well as to identify possible effects from an employee and business perspective.

With this in mind the authors' objectives are to answer the following two research questions.

- How can TPM be applied in a support process?
- What business and employee effects can be achieved if using TPM in a support process?

Theoretical framework of TPM

In the past, maintenance has been implemented in different ways. Until the Second World War a reactive approach was present, which means that an action had to carried out only in case of a failure. After the war the approach changed to become preventive: maintenance was planned after a defined period, according to the time of use to prevent possible failures. Later

in the 1970's the used methods became more predictive to discover potential malfunctions in the machineries. The development of TPM started in the 1970's, where its purpose was to achieve zero failures and zero faulty products (Nakajima, 1988). The 1980's brought a holistic view, which connected all production departments in the companies (Alsyouf, 2007).

After the Lean philosophy was coined in 1988 (by Krafic in a report comparing US, European and Japanese car manufacturer systems) it has since then developed (Hines et al., 2004; Womack and Jones, 2003) through, for example, moving into other areas, such as healthcare (Souza, 2009), construction (Jörgensen and Emmitt, 2008), and public sector (Radnor and Walley, 2008). Some authors argue that TPM is a method in Lean, while some say it is a philosophy on its own. (Mohammad et al., 2010). Today the method poses a challenge since there is no coherent definition of Lean (Andersson et al., 2006), but there are elements and key attributes that can be connected to Lean. A key aspect is the reduction of waste and non-value added activities, and hence the reduction of the cost base of an organization, which is also the objectives in TPM (Crespo et al., 2009).

TPM can be one key enabler for improved production performance and support the reduction of waste from a.o. unplanned work areas (Ahjua and Khamba, 2008; Ljungberg, 2000). Implementing a TPM approach in a production context can improve parameters, such as cost, quality and delivery, and will support the reduction of waste (McKone et al., 2001). Companies can be classified along three ways of implementing TPM, companies that have the structured and working methodology, those that say they have it, and finally those that have established the pillars (Rodrigues and Hatakeyama, 2006).

According to Japan Institute of Plant Maintenance (JIPM) eight pillars support the TPM house. The foundation is 5S, but the most important elements to implement TPM are training and involvement of the employees, see figure 1. For practical implementation companies have to overcome several barriers. In the literature personal, organisational and cultural barriers are identified.

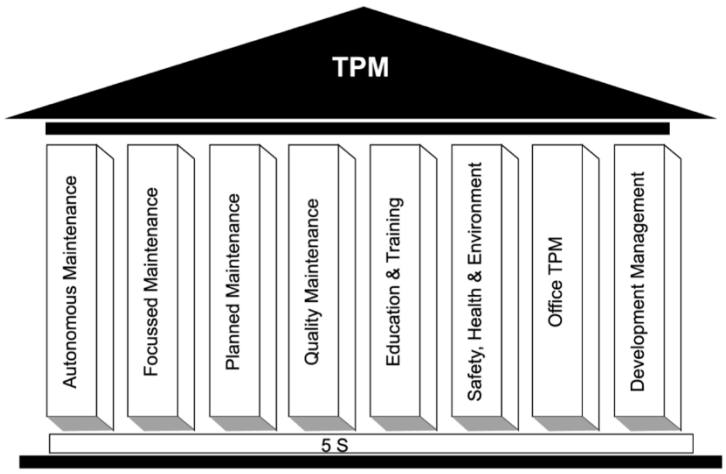

Figure 1. The TPM house, the eight pillars and 5S, from Japan Institute of Plant Maintenance (JIPM)

Personal barriers can arise because TPM needs a different behaviour from the employees, who should behave more like owners than just order consumers. They should be motivated to share knowledge and experience as well as to work in teams.

Organizational barriers are created by the lack of communication between the employees as well as the lack of training and education to handle this new philosophy. Further departmental problems are usually linked to the continuous flow of information and the teamwork approach. Financing can become an issue because of the long-term horizon of TPM. The large investments initially required are a risk and the payback is not immediately visible.

Cultural barriers arise because of the resistance shown by employees against such a radical change in the way of conducting maintenance.

For an effective TPM and maintenance strategy the whole company must be involved (Ahjua and Khamba, 2008) from production to support processes in the company (Kot and Grondys, 2013). Part of the TPM approach is “office TPM” where the key purpose is to enable the manufacturing operation by effective administrative systems (Shamsuddin et al., 2005). The office TPM includes application of 5S, focus on cost related issues, and elimination of procedural issues, and improves cooperation between departments (Ahjua and Khamba, 2008). The involvement and participation of the employees is a key part of office TPM to create a system where it is everyone’s responsibility to carry out maintenance and work preventively (Nakajima, 1988).

Lean’s three M are regarded as a key element in Lean. The first one is Mura (unevenness), the other two Japanese terms connected to Lean is Muda (waste) and Muri (overload), which is also applicable in a service context. Service is maybe the area where the most waste exists, according to Bicheno (2008). According to Chen and Cox (2012) if the processes have less variation and waste the three M will be improved, and as office processes in companies often contain more variation than repetitive production processes (Chen and Cox, 2012), working with TPM in office environments might be more advantageous than in production environments.

In Lean seven different wastes in office are defined, but today there are suggestions of additional waste, where one is the most prominent, viz. under-utilizing capabilities/skills. These wastes have been transferred or adopted into a service context (Luciano, 2009). Table 1 presents the view of Bicheno (2008) from a service context and Poppendick and Poppendick (2003) from a software development context. Reviewing the different wastes described, the similarities between the three authors can easily be detected, and Liker (2003) argues that the eight wastes can be applied in a development context and office context and a manufacturing context making the different descriptions more like dialects of the same language, see table 1.

Table 1. Different description of waste (Liker, 2003; Poppenick and Poppenick, 2003; Bicheno, 2008).

The Toyota way, Eight wastes (Liker, 2004)	The seven wastes of Software development (Poppenick & Poppenick 2003)	The forten wastes of the office (Bicheno 2008)
Excess inventory	Partially Done Work	Sorting and Search
Overprocessing or incorret processing	Extra Processes	Inappropriate measurements
Overproduction	Extra Features	Underload
Unnecessary transportation or conveyance	Task Switching	Overload
Waiting (time on hand)	Waiting	Inappropriate prioritising
Unnecessary movement	Motion	Interference
Defects	Defects	Inapproraite frequency
Unused employee creativity		Start up & End off
		Mistakes, Errors, or lack of appropriate knowledge
		Misunderstanding or communication error
		Sub-optimization
		Waiting
		Inappropriate presence
		Inappropriate tradeoff

The purpose of 5S is to facilitate work at the workplace by standardization and organizing. It is based on five simple activities, which according to can be described as followed (Srinivasan, 2012; Chapman, 2005):

1. Sorting (Seiri): Identify and eliminate unnecessary items such as tools, material and other waste by organizing the workstation.
2. Storing (Seiton): Place tools and material in such a way that they easily can be picked when needed.
3. Sanitizing (Seiso): After usage, tools should be place at the original location and the working station should be clean and cleared from dirt in order to improve efficiency and identify and prevent possible defects.
4. Standardizing (Seiketsu): The previous steps should be performed as a routine, which involves maintenance of the workstation, machines and tools. Instructions on how to perform work properly and solve complications should be developed in order to minimize deficiencies.
5. Sustaining (Shitsuke): Develop a company-wide approach for continuous improvements and evaluation of the flow. It is essential for operators to work together in the same direction towards future goals and remind each other to maintain the “orderliness”.

According to Heizer and Render (2011), in order to eliminate waste and at the same time maximize output with a minimum level of input, 5S should be implemented. Moreover, Srinivasan (2012) states that 5S improves safety, work efficiency, productivity and provides employers with a sense of ownership. However, there are major fall-backs when not committing to the “lean journey” by discontinuing a full Lean implementation.

A 5S approach has a positive impact on performance parameters in terms of productivity and quality (Bayo-Moriones et al., 2008). The 5S is as useful in the office environment as in

production (Sörqvist, 2004). But the development and usage of 5S in a service context have not reached the same level as in production (Gapp et al., 2008). On the other hand when starting with Lean in office context companies often start with 5S, and the ideas have been transferred into the office environment in many companies today. Maybe the most important within 5S is to create standards for work in order to perform the main tasks (value adding time) more effectively and efficiently (Heizer and Render, 2011). This has also the same importance as for TPM in office, which is "managing an effective administrative system to support manufacturing operations" (Shamsuddin, 2005).

Methodology

A qualitative research approach was based on a case study providing empirical data to analyse and answer the research question.

The case company is operating within the telecom sector and has ten different production sites in different locations globally. The company has a common approach to work with Lean production. One of the company's Swedish sites was identified to be working with ideas how to adopt maintenance in an office context.

The empirical data was collected by the use of two different methods. The first method was on-site semi-structured interviews with respondents, and the second was an email questionnaire with three open questions. The reasons for differentiating the methods were time limitations agreed with the case study company. The respondents were selected in discussion with the company and came from four different teams within the company, operational development, supplier development, production logistics and technical support. All the respondents were familiar with prevention maintenance in production processes. The teams were selected to get a broader view of the application of methods and concepts in different types of teams. In total eight respondents were selected and interviewed. An additional email questionnaire sample of eight respondents from the same teams as in the interviews was selected. The email responses were used to verify results from the semi-structured interviews. The response rate was 100% for the questionnaire.

The data to describe the method of preventive maintenance was collected by letting the manager and one team member describe the method. One of the authors also participated in two meetings, where the preventive maintenance tool was handled. One of the authors works as manager in the case company but was not involved in the interviews in order not to influence the respondents and the results of the interviews.

The case company

The case company has been working with Lean implementation since 2005, defined as an internal implementation program. As part of the Lean implementation the site started to adopt

the Lean ideas in their production processes, and after some time the scope expanded to also include the support processes.

The case company identified problems in their office processes, such as with information, documentation, presentations or web pages not being up-to-date; it was in this situation the idea to apply TPM in the office context came up. Thus the case study refers to a specific way of applying structured daily work with preventive maintenance in focus, in support processes or the office context.

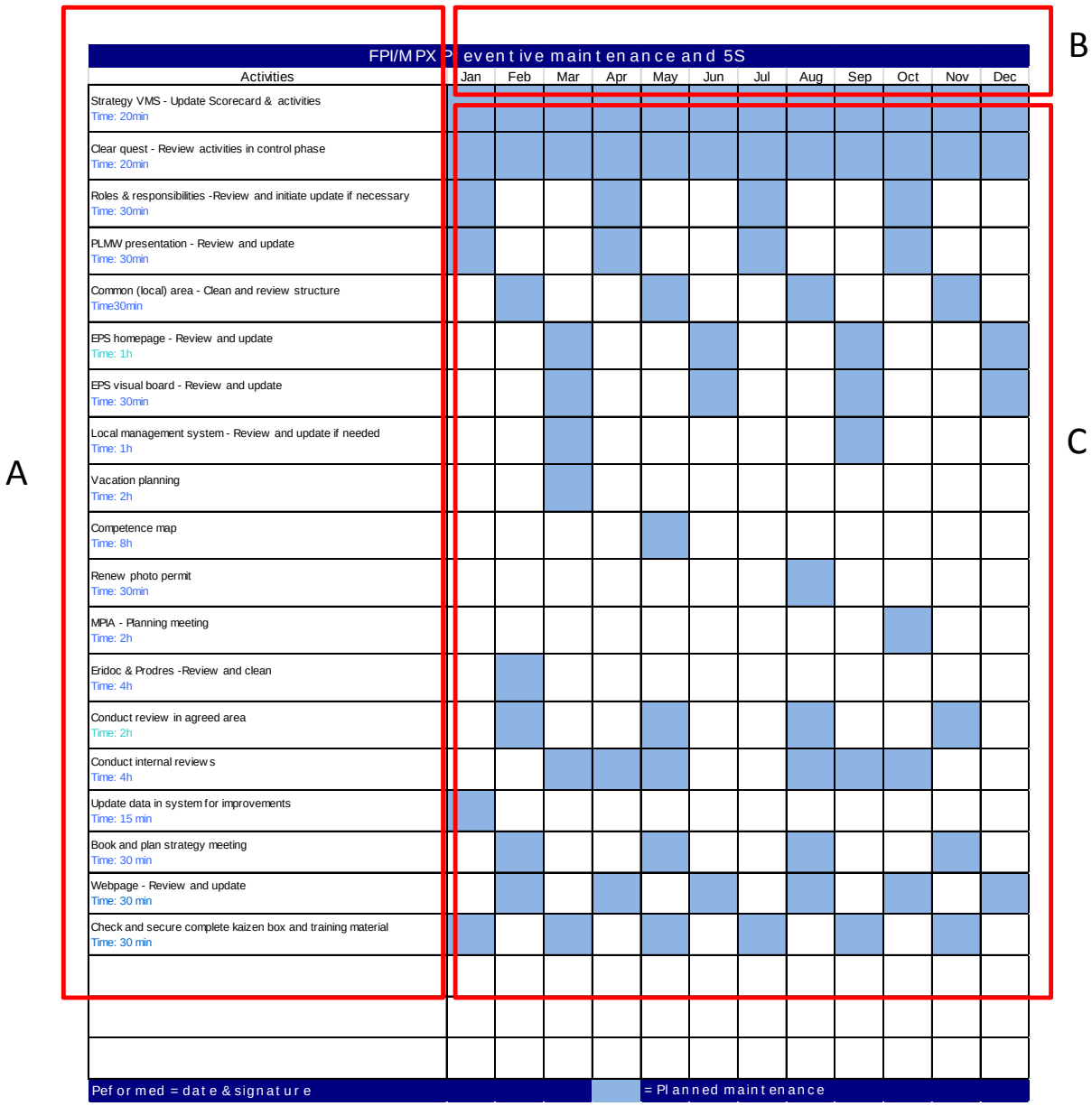

Figure 2. The TPM and 5S spreadsheet (adopted from the case company).

The TPM work is related to materials that need to be updated on a continual basis in order to be ready to use for employees when needed; thus it contains presentations and other relevant documents. A typical example is a Site visitor's presentation file that contains figures and numbers that always change and needs to be up-to-date (as the story in the introduction above). The procedure is applied at team level at every office department in the company. All activities and documentations, which the team uses or are responsible for, are identified and defined in an Excel spreadsheet and presented in field A, see figure 2. An instruction for what needs to be done connected to each maintenance activity is defined as well as the frequency of the maintenance activities. For each maintenance activity the occurrence is defined to be performed monthly, bimonthly, quarterly, semi-annually or annually. For visualization purposes a blue dot is used (see field C, figure 2) for knowing what time a certain maintenance activity must be carried out. In order to secure that every department and employees do it in the same way an instruction how to perform maintenance and how to update the materials is connected to the main routine.

Results

TPM applied in a support process

The case company has the TPM document printed on an A4 paper, and it is visualized on the departments' improvement board, see figure 3. Almost all the departments have "stand up meetings" every morning or once a week, but a maintenance meeting is included and performed once a month, thus the meeting agenda reviews which activities that are to be performed. Each activity is also assigned to an individual team member. The initials of the responsible team member are written with a marker in the blue square connected to the activity. When the maintenance activity is performed, the team member erases the marker and writes with a pen his initials and date when the activity was performed. At the meeting the past month's maintenance activities are also reviewed, and if there are over-due maintenance activities these are discussed and actions defined to mitigate the problem. As part of the meeting new activities are brought up and if needed added to the spreadsheet. Improvements of existing maintenance activities are also discussed and handled during the meeting.

Figure 3. Visualized practical working sheet on the departments' improvement board (adopted from the case company).

There is also a connection between 5S methods and the maintenance A4 paper, because the 5S work is related to materials that need to be updated on a continuous basis and requires standardized maintenance. Therefore the case company has included 5S in TPM. That strategy is also supported in literature by Ahjua and Khamba (2008) and McKone et al. (1999). ¨Thus 5S could be seen as a first step to implement TPM and it could be advantageous to include it. In order to work with 5S there must be a common standardized approach that must be maintained continuously, otherwise the 4th and 5th S will not be fulfilled (Nakajima, 1988). Moreover the greatest difficulty in 5S is to sustain the last S (Chapman, 2005); thanks to the TPM office the case company has overcome the obstacles and has today a good procedure for that.

To overcome personal, organizational and cultural barriers all employees have had training for at least two days in TPM and 5S, several of them one week, in order to have the same direction/behaviour and become involved. Different team members are chairman at the daily meetings in order to sustain a long-term horizon of TPM that involves everyone, not only the manager. In the meeting, continuous improvement, sharing knowledge and sharing experience are always stressed as well as working together in teams to solve problems or find better solutions. Every employee has his share in the success of the company that gives an atmosphere of all roles and employees being important. Thanks to the visualization boards other departments' employees can watch the improvements and what is going on at the movements. There are also regular meetings between different departments' managers in order to share knowledge between departments. These meetings also improve communication in the company. After working with TPM for many years in production, the white collar employees have seen the benefit of it, today they know it is a method to sustain long-term horizon strategy and work with TPM, and automatically the Lean's three M will be improved, -"It is not a choice to have it or not" as one employee mentioned.

What business and employee effects have been achieved?

Before, TPM only involved production and some support processes, but today it is performed throughout the entire case company's processes and departments. Today it is easier to share knowledge and experience thanks to a common way of working. The teams' ways of working have become more agile, and everybody can understand and see that all white collar employees are involved in the improvement processes, not only those connected directly to the production. In the office environment employees from other departments can make improvements that are advantageous for all departments, thanks to common methods. It will be easier to work between departments by more effective administrative systems and flexibility in the form of sharing employees between departments. Furthermore cost and quality have been improved due to the fact that the department can share improvements of procedures. When an employee gets the tasks he knows that they will be automatically shared by the other departments, giving more effort to the tasks, and the quality will be better than before. TPM is an enabler to remove waste, more or less all waste in Table 1 has been reduced, thanks to the TPM and connected 5S procedures, which is also the objective in TPM (Crespo et al., 2009; Ahjua and Khamba, 2008). It reduces the time to find and plan what needs to be reviewed and possibly updated. It reduces wastes in the form of looking and rework and provides a possibility to plan and reduce ad-hoc activities. It gives a clearer holistic view. Maybe the most important within 5S is to create standards for work, which is also the same importance as for TPM in office (Shamsuddin, 2005; Heizer and Render, 2011), and in order to sustain the 4^{th} and 5^{th} S in 5S the TPM approach is very beneficial. Therefore 5S and TPM should be integrated, which the case company has done with great progress.

The structure that has been applied within the company enables the employees to secure that tasks will not be forgotten. It also gives the possibility to plan and work ahead to create a proactive structure, especially for activities with a long time between reviews. There had also been less error and reduced risk for new errors. Before, instruction and documents were sometimes missed, when there was no structure to secure a review. The individual employee feels it is more comfortable to have a presentation when he knows it is updated, and he needs only a few minutes for preparation. Everything has been more visualized from the basic level to more advanced, for example to find and when to discuss all employees annual vacation to know that the information in the web page is up to date, it is also comfortable to know that the meeting room has the right equipment, which works.

Changing from individual responsibility to team responsibility, TPM also removes the dependency of specific employees. In times of high workload or internal mobility of people it was often easy to miss or forget activities; in these cases TPM has helped a lot.

The work with TPM in the production environment was a catalyst to overcome organizational and cultural barriers as a result of several years of successful improvement work. Training issues that need to be addressed for success with TPM according to Kanta et al. (2005) and similarly a full commitment of senior management, which is performed and fulfilled in the case company. The TPM house and the eight pillars for production already have some influence in office environments, which may have boosted implementation of TPM in all administration processes. It is not a totally new approach of working with TPM.

It had been more tricky to overcome personal barriers, and it is not yet solved to 100 percent; all departments use TPM, but some employees are still not convinced about it, and sometimes they miss the regular meetings. It could work well without these routines and meetings and each activity can be allocated to the individual employee’s responsibility for work tasks. For example, in a department with few employees, it is easier not to forget anything, and it takes time to have meetings. Another drawback could be that TPM results in a high level of supervision, implying a negative impact on innovation and creativity.

Discussion and conclusion

Maintenance plays a strategic and crucial role in every production company today. The way maintenance policies are implemented can affect the productivity and profitability of the company, as it has a direct influence on quality, efficiency and effectiveness. Furthermore 5S need TPM and it is easy to include 5S into TPM.

TPM represents a possibility to ensure higher productivity and profitability, lowered costs, reduced breakdowns (if the presentation files are not found), improved quality and working conditions, assured safety as well as increased employee’s motivation. It requires teamwork, long-term commitment, workers involvement, management support and training. It can be a

strategic opportunity for every company to improve their processes in a standard way, and TPM is one step in that direction.

TPM needs a strong commitment from the whole workforce within the company, continuous improvement and day-to-day activities and, most important, it is a long term decision. Furthermore the TPM office approach is suitable for companies who implement or run Lean manufacturing (Ahuja and Khamba, 2008).

Back to the story that introduced the paper. After two years and implementation of the TPM structure and approach that has been described in the paper, the following scenario applies:

During the upcoming week there is a planned visit from a customer. The first thing to do for an employee is to give a presentation with basic information of the company, after that a site tour is planned. He knows how to find the latest presentation and is very comfortable knowing there are no errors, and that it is up-to-date with the latest figures, pictures and products. The employee responsible for the visit starts with now only 20 minutes preparation. He has no need to disturb other colleagues with questions. He does not need to upload it before the visiting tour, he can do that while talking to the customer just before showing it. At the end of the visit he asks the customer about some improvements and sends the suggestions to responsible employee that is visualized on the corner of the presentation slides and direct linked to his mailbox.

For production a TPM approach can improve key objectives, such as cost, quality and delivery, and will support the reduction of waste (McKone et al., 2001). All these objectives have been improved in the story above, as well as in the case company after implementing TPM office.

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