MSc Program
Engineering Management

TOTAL PRODUCTIVE MAINTENANCE

A Master's Thesis submitted for the degree of
"Master of Science"

supervised by
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11. 11. 2011, Trnava

Affidavit

I, **ING. PAVOL BARTKO**, hereby declare

1. that I am the sole author of the present Master's Thesis, "TOTAL PRODUCTIVE MAINTENANCE", 82 pages, bound, and that I have not used any source or tool other than those referenced or any other illicit aid or tool, and
2. that I have not prior to this date submitted this Master's Thesis as an examination paper in any form in Austria or abroad.

Vienna, 04.11.2011

Signature

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II LIST OF ABBREVIATIONS

AM – Autonomous Maintenance

CAM – Capacity Assurance Management

CIM – Computer Integrated Manufacturing

CMMS – Computerized Maintenance Management System

CBM – Condition Based Maintenance

EMIS – Equipment Management Information System

FEMA – Failure and Effects Mode Analysis

JIPM – Japanese Institute of Plant Management

JIT – Just In Time

LM – Lean Manufacturing

MTBF – Mean Time Between Failure

MTTR – Mean Time To Repair

OEE – Overall Equipment Effectiveness

OPE – Overall Plant Efficiency

PE – Performance Efficiency

PDM – Predictive Maintenance

PM – Preventive Maintenance

RCM – Reliability Centered Maintenance

RE – Rate Efficiency

SE – Speed Efficiency

SMED - SingleMinute Exchange of Die

TBM - Time Based Maintenance

TEI – Total Employee Involvement

TPM – Total Productive maintenance

TPM1 – Total Productive Manufacturing

TQC – Total Quality Control

TPR – Total Process Reliability

ZF – Zero Fails

ABSTRACT

The success and effectiveness of modern lean manufacturing concepts requires robust and higly reliable machinery. In this thesis I will compare the performance of a manufacturing system under different maintenance polices. The main focus of this work is to compare traditional time based maintenance policies with reliability based predictive maintenance policies that utilize real time sensory information to assist in decisions regarding maintenance management and component replacement. In this thesis I will demonstrate the benefits of using sensor based predictive maintenance to predict failure.

PROBLEM FORMULATION

T&L, factory where I am working for is disciplined focusing on growing of our specialty food ingredients business. This fact is driving our bulk ingredients for sustained cash generation to fuel this growth. Therefore we have prioritized our operational strategy in the next order. Safety is remaining the first priority, but operational reliability is becoming our second most important priority. To ensure our operational strategy we have to define our present maintenance stage and decide if are we able to introduce the reliability centered maintenance (RCM), either the total productive maintenance (TPM) into our daily life. What is wrong with the current system of maintenance for a team of skilled technicians, who can put together almost every machine after the failure? After all, they still carry out their duties as they should. The system of maintenance is not adequate. The most probably is, that the machine is repaired only when the broken machine is causing a serious downtime. Machine failure is causing the depreciation of the assets, increasing of repair costs and loss of production. If the worker performs only command to replace the broken parts only and does not solve the problem independently and immediately, the company loses money! These are the fundamental reasons for the introduction of TPM. Maintenance has to avoid the consequences of the failure not only by applying of reactive and preventive maintenance, but involving all staff into the continuous process of caring out for machinery and equipment and autonomous teams have to be deeply involved into the maintenance of its machinery and organized good time based management of equipments. Introducing TPM in a Eastern European country, such as Slovakia, is still considered as a major challenge due to several non conducive environments in the adoption and implementation process. Lack of commitment and leadership from top management has always been discussed as one of the main factors that inhibit the implementation of TPM. On the other hand, resistance from the employee involved in the TPM program is also regarded as another major reason that explains why TPM fails in many local organizations. Employees refused to endure extra maintenance responsibilities without any rewards, recognition or compensation. Lack of proper and adequate training and education about TPM also contributed another significant percentage to the pitfalls of TPM implementation in a Eastern European country.

1. Introduction

Total Productive Maintenance, or TPM for short, is advanced manufacturing technique that focuses on maximizing the overall equipment effectiveness of any asset utilized in the production of goods and services. While the basic components of TPM have been in existence for decades, few companies are able to assemble the components into an overall strategy. Many companies will partially implement some of the components, but never realize the full benefits that can be achieved through TPM.

One of the primary issues companies face while attempting to achieve TPM is the organizations perception of TPM. Many companies will fail to achieve results because of the paradigm around the world “Maintenance. “ For example, in some organizations maintenance is described with words such as:

Overhead,

Necessary Evil,

Expense,

Prima Donnas,

Fire Fighters,

Janitors

These organizations have a negative paradigm about the maintenance function.

In contrast, some organizations describe maintenance with word such as:

Preventive,

Predictive,

Reliability,

Technicians

These organizations have a positive paradigm about maintenance and will be able to achieve TPM results in more rapid timeframe.

Organizations with a negative paradigm about maintenance may take three to five years and perhaps even longer, to fully achieve the benefits of TPM. Some organizations have even found that the maintenance function was viewed so negatively they had to rename the function before they could make a progress. For example, some companies use the acronyms:

TPR:	Total Process Reliability
RCM:	Reliability Centered Maintenance
TPM1:	Total Productive Manufacturing
CAM:	Capacity Assurance Management

Ultimately, it does not matter what the process is called. What really matters are the results that are achieved. The purpose of this Thesis is to outline a methodology that can be used to implement TPM successfully. Whether a company uses another acronym to describe TPM does not matter. When all is finished, the results are what matter. It is hoped that by applying many of the suggestions contained in this Thesis, companies can not only implement TPM, but also achieve the financial benefits that are available. (Wireman, 2004).

1.1. Motivation, Problem definition.

The purpose of this thesis is to determine and examine the activities necessary for my company to prepare the Total productive maintenance (TPM). These activities include a clear understanding of what TPM really is as well what it is not. I will examine the current state of maintenance management in the T&L, while illustrating why improvement is vitally important to the company. I will also highlight pre implementation activities that must be considered before any TPM program can be successful. In order to properly understand the history and impact of total productive maintenance, it is necessary to establish a definition. Total productive maintenance (TPM) is maintenance activities that are productive and implemented by all employees. TPM involves everyone in the organization from operators to senior management in equipment improvement. It encompasses all departments including:

Maintenance

Operations

Facilities

Design Engineering

Project Engineering

Construction Engineering

Inventory and stores

Purchasing

Accounting and Finance

Plant and Site management

1.2 The main research problem.

It is difficult to imagine a time when equipment was not maintained. Remarkably enough, maintenance and productivity have not always been the Holy Grail of industry that they have become in todays most successful companies. Yet it surprises me to discover that even in the twenty-first century, there are still a large number of companies who appear to be oblivious of the potential gains that await them. They will probably never consider improvement techniques unless they find themselves in difficulty, at which point they will seek help from everyone: professional and government organizations like the Manufacturing Institute, the Department of Trade and Industry (DTI), and Scottish Enterprise. It does make me wonder, however, how many companies actually are aware that there are better ways out there but simply will not take steps to do anything about them.

Reactive maintenance ruled the roost in the early days of manufacturing. If we look back, we discover that there was no real need to be efficient. There was a huge surplus of workers and cheap labor. Such a pool of labor and the capability to produce all of the goods that everyone wanted was enough to satisfy industry. When production halted the problems would be fixed and production would restart . . .whenever. . . . The goods would simply be delivered late. There was no need to avoid breakdowns. Any preventive maintenance was limited to a tap with a hammer, oil, or a grease gun. Besides, the equipment was very solid, robust, and built to last. Why should they have given a second thought to efficiency?

As we entered the twentieth century, mass production was seen as the way to reduced prices. The more product that was made, the cheaper the selling price could be. So some experts started thinking about ways of increasing output, but not really from todays engineering perspective. Henry Fords efficiency expert (Frederick Taylor) basically just wanted to make employees work harder. Taylors approach was to break down manufacturing and assembly into the smallest practical steps possible to use as many men as it took to carry out all of the steps, and to minimize any need for skilled employees. To be fair, he did seem to have some ideas on factory layout and Ford did have production cells in his first factory. In any case, in 1913, Henry Ford hit on the monumental idea of the moving production line, which did speed up production.Then along came two World Wars. The overflowing labor pools were drained as they poured their contents in the direction of the war effort. Supporting the war and of course, supplying soldiers knocked production off balance. In order to keep industry moving, it was necessary to use women to top up the pools. Women were trained to carry out tasks previously regarded as suitable only for men. As it turned out, many of the women did the jobs even better than the men. The mothers became a very good welders. Having the labor was only part of the answer. The goods were still not shipping fast enough. With the extra demand on the machines came anincrease in breakdowns. It rapidly became apparent that the previous expectations of industry and the inefficiency of reactive maintenance were just not good enough. Breakdowns had to be reduced if there was to be any way to increase output. Not only that, the shortage of raw materials now focused attention on the levels of waste. Cutting the cost of losses became a serious consideration. As if all this was not enough, the manufacturing equipment designs were increasing in complexity and required an even higher level of skilled support to operate and maintain them. The engineering answer of the day was Time Based Maintenance, which did help a bit. This was the era of PM.

By the time we get to the seventies and onwards, the bogeyman was profits. Now we see the development of TPM and RCM. With customers looking for even more reduced cost of ownership of equipment the cost of running a piece of equipment had to be reduced, despite its complexity still increasing. Then another requirement crept into play: quality. In the sixties and seventies, the car and the electronics industry were not too reliable. To be fair, at one point, both the British and the Japanese products were equally bad, but the Japanese goods began to get better. And better. Today, Japanese car manufacturers are always in the top five of the car reliability tables and their equipment leveland price position them at the top of the sales tree. Why? Japanese industry believes the needs of the customer come first. This, fortunately leads to increased sales, greater customer satisfaction, fewer after-sales problems, and finally even more repeat sales. This leads to more profit.The last impetus for manufacturing improvement was safety. This was driven by legislation. Today, it is possible to be imprisoned if an injury can be proven to be the result of negligence by a manager. Similar requirements have been placed on environmental pollution, but the laws tend to be a tad more complicated. How was it possible for the Japanese to transform their industry so effectively? One treatment was the development and successful application of TPM. Industry in Europe and America believed that only technical groups had any practical input on improving the performance of equipment. This was true to a point. If the maintenance situation was very poor, then the benefits in repairing that situation could seem out of proportion. The Japanese new maintenance was not the complete solution. In fact they held the view that production had a major input. In retrospect, this view was so obviously correct that it seems ridiculous that no one else realized it. Nevertheless, it was pretty innovative to see companies making improvements on the basis of the needs of all of the equipment users as well as the engineers. True optimization of equipment could only be achieved with the active input of the production groups, particularly the operators. Lucky for us, though, the benefits of TPM are achievable by anyone who is prepared to make the commitment and follow a few simple disciplines to be discussed further.

RCM is also equipment based, different from TPM and a bit harder to understand. It too relies on input from operators, production, and process engineers. Its longevity is based on a fundamental premise that any maintenance that could be carried out should be considered and evaluated against the cost and the consequences of failure. It requires a different way of thinking but it is well worth the effort. It is my view that TPM and RCM complement each other. This to be researched further.

1.3 Hypothesis of the Research

Identify the curent stage of maintenance level in T&L Slovakia.
Identify failures or losses and analyze causes.
Identify the common and individual pitfalls and difficulties during TPM implementation.
Identify key resources and assistance that were necessary for successful TPM implementation.
Is the maintence strategy defined and can be developed ?
Are we able with curent sources to implement TPM ?
Is the reporting structure of operations in line with TPM implementation ?
Identify key resources and assistance that were necessary for successful TPM implementation.

1.4 Aim and Structure of the Thesis

The aim of this thesis is to prepare an theoretical guidline for TPM implementation and study material for the future use.

The master thesis are structured as theoretical part from the beginning thru hypothesis statement and research approach, models, description and discussion of the data collected.

2. Developing the Maintenance Strategies

In the past years, executive management has focused increasingly on short term profitability, sacrificing their physical assets to do so. Best Practice companies have taken advantage of this trend to develop strategic plans, building strong, complete organizations. One of the foremost areas of focus for these companies has been the maintenance management function. Maintenance is extremely important to being competitive in the world market. There a plants where one day the maintenance force is required to work on sophisticated electronic systems and the next day to perform janitorial service in the lavatories. In this environment, it is difficult for maintenance personnel to develop a positive attitude of their value to the corporation. If the maintenance function is to become a contributing factor to the survival of companies, management must change their views toward maintenance. If they do, they can achieve world class competitiveness. Achieving the goals necessary to have a strong maintenance organization one that contributes to increased profitability will require decisions concerning the maintenance organization and the type of service it provides.

2.1 Goals of TPM

TPM has the following five goals (Wireman, 2004)

Improving Equipment Effectiveness.

Improve Maintenance Efficiency and Effectiveness.

Early Equipment Management and Prevention.

Training to Improve the Skills of all people Involved.

Involving operators in Routine Maintenance.

2.1.1 Improving Equipment Effectiveness.

This goal which insures that equipment performs to design specifications, is the true focus of TPM. All remaining goals for TPM are valueless unless they support improving equipment effectiveness. The focus must be that nowhere in the world can another company have the same asset and make it produce more than your company can produce. If it does, than it is better at managing its assets than your company and will always be lower cost producer or provider.

The equipment must operate at its design speed, produce at the design rate, and produce a quality product at these speeds and rates. A major problem occurs because many companies do not know the design speed or rate of production for their equipment. In the absence of knowing the design criteria, management will set arbitrary production quotas. A second major problem develops over time when small problems cause operators to change the rate at which they run equipment. As these problems continue to build, the equipment output may only be half for which it was designed. This inefficiency then leads to be investment of additional capital in equipment, trying to meet required production output. (Wireman, 2004)

2.1.2 Improve Maintenance Efficiency and Effectiveness.

This goal focuses on insuring that maintenance activities that are carried out on the equipment are performed in a way that is cost effective. Studies have shown that nearly one third of all maintenance activities are wasted. Therefore, this goal of TPM is important to lowering the cost of maintenance. It is important for all to understand that basic maintenance planning and scheduling are crucial to achieving low cost maintenance. The goal is to insure lean maintenance, with no waste in the maintenance process.

A secondary goal is to ensure that the maintenance activities are carried out in such a way that they have minimal impact on the up time or unavailability of the equipment. Planning, scheduling and backlog control are again all important if unnecessary maintenance downtime is to be avoided. At this stage, maintenance and operations must have excellent communication in order to avoid downtime due to misunderstandings.

Developing an accurate database for each piece of equipments maintenance history is also the responsibility of the maintenance department. This history will allow the maintenance department to provide accurate data for decisions related to the plant or facility equipment. For example, the maintenance department can provide input to equipment design and purchase decisions, assuring that equipment standardization is considered. This aspect alone can contribute significant financial savings to the company. Standardization reduces inventory levels, training requirements, and start up times. Accurate equipment histories also helps stores and purchasing not only reduce downtime, but also avoid carrying too much inventory. (Wireman, 2004)

2.1.3 Early Equipment management and Maintenance Prevention

The purpose of this goal is to reduce the amount of maintenance required by the equipment. The analogy that can be used here is the difference in the maintenance requirements for a car built in 1970 compared to car built in 2000. The 1970 car was tuned uo every 30 – 40 000 miles. The 2000 car is guaranteed for the first 100 000 miles. This change was not brought about by accident. The design engineer carefully studied the maintenance and engineering data, allowing changes to be made in the automobile that reduce the amount of maintenance. The same can be true of equipment in a plant or facility.

Unfortunately, most companies does not keep the data necessary to make these changes, either internally or through the equipment vendor. As a result, unnecessary maintenance is performed on the equipment, raising the overall maintenance cost. (Wireman, 2004)

2.1.4 Training to Improve the Skills of All People Involved

Employees must have skills and knowledge necessary to contribute in the TPM environment. The requirement involves not only the maintenance department personnel, but also the operations personnel. Providing the proper level of training insures that the overall equipment effectiveness is not negatively impacted by any employee who did not have the knowledge or skill necessary to perform job duties.

Once employees have the appropriate skills and knowledge, their input or equipment improvement needs to be solicited by senior management. In most companies, this step only takes the form of suggestion program. However, it needs to go well beyond that, it should also a management with an open door policy. Such a policy indicates that managers from the front line to the top are open and available to listen to and give consideration to employee suggestions. A step further is the response that should be given to each discussion. It is no longer sufficient to say “That will not work“ or “We are not considering that now.” In order to keep communication flowing freely, reasons must be given. Therefore, managers must develop and utilize good communication and management skills. Otherwise, employee input will be destroyed and ability to capitalize on the greatest savings generator in the company will be lost. (Wireman, 2004)

2.1.5 Involving Operators in Routine Maintenance.

This goal finds maintenance tasks related to the equipment that the operators can take ownership of and perform. These tasks may amount to anywhere from 10-40 % of routine maintenance tasks performed on the equipment. Maintenance resources that were formerly engaged in these activities such as predictive maintenance or reliability focused maintenance activities. It must be noted: the focus for the operations involvement is not to downsize the maintenance organization. Instead, the focus is to free up maintenance resources for the more technical aspect of TPM. (Wireman, 2004).

2.2 Cost Benefit of TPM Goals (Wireman, 2004).

Productivity

100-200 % increases

50-100 % increase in rates of operations

500 % decrease of breakdown.

Quality

100 % decrease in defects

50 % decrease in clint claims

Costs

50 % decrease in labor costs

30 % decrease in maintenance costs

30 % decrease in energy costs

Inventory

50 % reduction on inventory level

100 % increase in inventory turns

Safety

Elimination of environmental and safety violations

Morale

200 % increase in suggestions

Increased participation of employees in small group meetings.

With all of these benefits, it is important for all companies to recognize the importance and value that productive maintenance can bring to the company. Any company trying to achieve World Class status through other programs such as Computer Integrated Manufacturing (CIM), Just in Time (JIT), Total Quality Control (TQC), Total Employee Involvement (TEI), or Lean Manufacturing, will soon find that these programs will not work without total reliability of the company`s assets, which is the primary responsibility of maintenance organization. In particular, Just in Time, Total Quality Control and Total Productive Maintenance are all essential. Without full utilization of these three programs, the goal of being globally competitive will never be reached. (Wireman, 2004).

2.3 History of TPM.

From where did TPM evolve? What spurred its developement? TPM originated in Japan and was an equipment management strategy designed to support the Total Quality Mangement strategy. The Japanese realized that Companies cannot produce a consistent quality product with poorly maintained equipment.

TPM thus began in the 1950s and focused primarily on the preventive maintenance. As new equipment was installed, the focus was on implementing the preventive maintenance recommendations by the equipment manufacturer. A high value was placed on equipment that operated at designed specifications with no breakdowns. During these same years a research group was formed, which later became the Japanese Institute of Plant Management (JIPM).

During the 1960s, TPM focused on productive maintenance, recognizing the importance of reliability, maintenance and economic efficiency in plant design. This focus took much of the data collected about equipment during the 1950s and fed it back into the design, procurement and construction phases of equipment management. By the end of 1960s, JIPM had established and awarde a PM prize to companies that excelled in maintenance activities.

Then in the 1970s, TPM envolved to a strategy focused on achieving PM efficiency through a comprehensive system based on respect for individuals and total employee participation. It was at this time that „Total“ was added to productive maintenance. By the mid 1970s, the Japanese began to teach TPM strategies internationally and were recognozed for their results.

This process was an evolutionary one that took time, not because it was technically difficult to produse the results, but because of the efforts to change the the organizational culture so that is valued „Total“ concept.

Today the international focus of TPM is intensifying. This interest is expressed to support the company`s full utilization of its assets. For example, one of the prevalent strategies today is the concept Lean Manufacturing. It is based on the Toyota production system and is designed to drive the waste from the organization. Lean Manufacturing strategies have yet to produce the true benefits possible bacause they assume full asset utilization. Furthermore, the full utilization of assets will never occure without an effective TPM strategy. Therefore, are Lean Manufacturing strategies effective today? The answer is no. A quik reviw of the current state of Maintenance in the United States indicates, that changes are required if companies want to achieve the benefits of Lean Manufacturing. (Wireman, 2004)

3. The State of Art

I started to use TPM techniques before I even knew that TPM exists. This is because much of TPM is simply good engineering practice. Just like TPM, I learned very early in my career that most equipment problems revolved around people. Either through lack of skills, lack of training, poor or no procedures. Often, the solution boiled down to the writing of a proper, standard procedure and some training.

3.1 The Pillars of TPM

TPM now comprises of eight different sections which have come to be known as pillars. Each pillar has its own areas of responsibility, but they also have areas where they overlap.

The pillars, identified in Figure 1, are as follows:

3.1.1 Health & Safety

This is crucial as it sets the goal of zero accidents. Its importanceis emphasized by the need to protect operators, who will be trained, initially, to carry out simple technical tasks. Bear in mind that most of the operators that will be participating in AM were not employed with maintenance in mind, no matter how simple. To this end, we must cover risk assessments, hazard maps, and some other safety concepts in detail. To build confidence in the operators, they should be trained in how to carry out risk assessments. They are also encouraged to help with the development of the safe working procedures.

3.1.2 Education & Training

In many companies, training is not given the importance it deserves.Procedures are often passed on informally on the job, and the trainee is required to make his own short hand notes in his log book. These are the instructions he is expected to use in the future when he carriesout the tasks by himself. This is highly ineffective as a training technique, as it assumes :

The trainer the qualified technician actually knows the correct method.

That the trainer can, without using a proper procedure, recall all of the steps and relevant facts in the correct order.

That he has the ability to explain what he is doing.

That the trainee is capable of understanding the topic.

That the trainee is capable of accurate note-taking.

That the trainee can draw proper, accurate diagrams.

That the trainee can learn at the same time as taking notes and following instructions.

Reliance on this method of training will cost the company lots ofmoney in the long run.

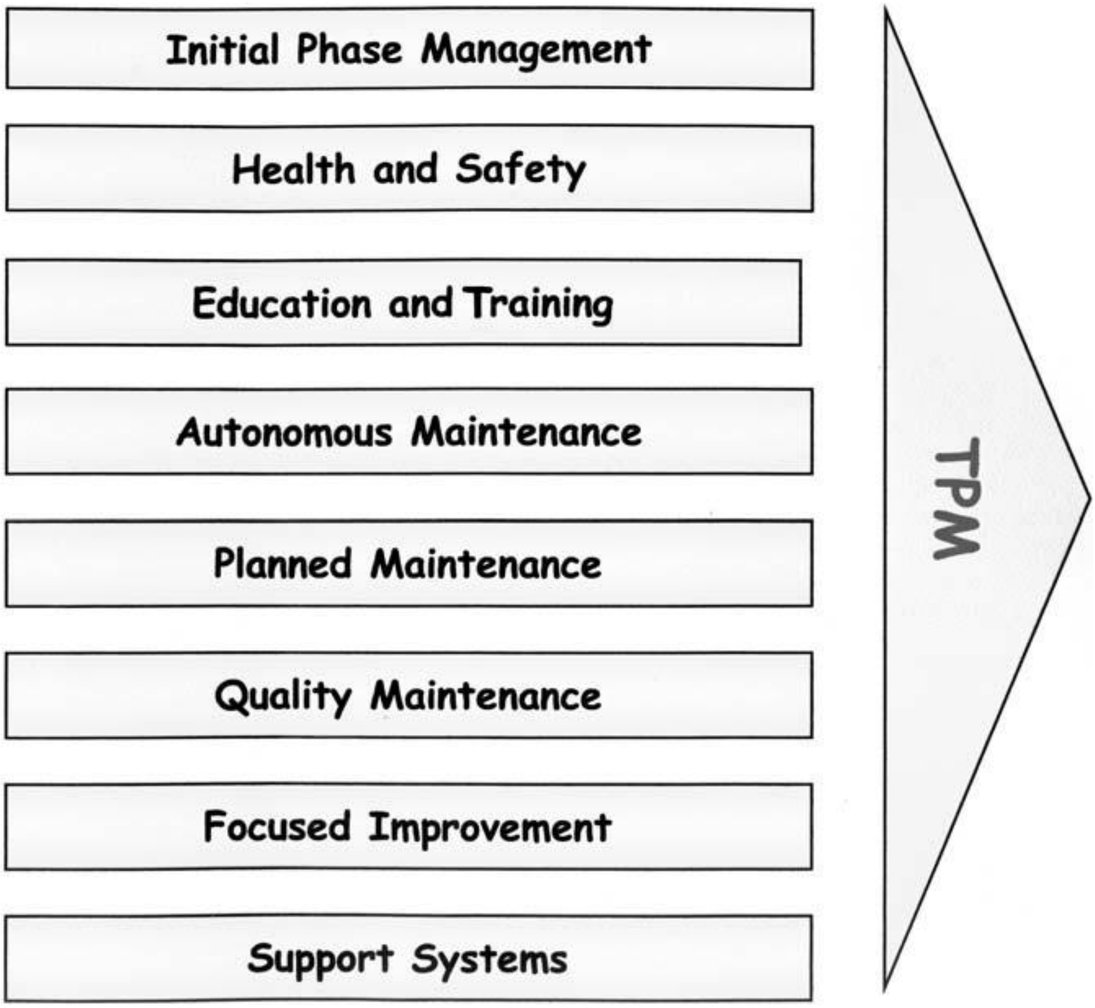

Fig. 1. The Pillars of TPM (Borris 2006)

Without proper training, TPM, and maintenance in general, will simply not work. This pillar explains what knowledge is necessary, how to teach it, and how to confirm it has been absorbed and has been understood. It is important that the competency of the operator is confirmed, not simply that they have attended a course. (Take a look at some vendor certificates; they often say that a person "has attended" a course. There is rarely any reference to understanding or performance.) All details of training must be recorded.

TPM also recognizes that the absence of proper training methods is not limited to industry, which is why it promotes the use of standard operating procedures. As a short example to reinforce the point, let me relate the story of a conversation with a trainee theater nurse. He was annoyed because he failed his test on an anaesthetic machine. It turned out his *experienced* instructor had missed out a few steps. The qualified nurse is expected to memorize the procedure and, once that has been done, there is often no further need to refer to the instructions. Which brings us neatly back to the reason for the poor training: the instructor should have used the instructions. It is the only realistic way to ensure every, essential step is covered and is correct.

3.1.3 Autonomous Maintenance (AM)

Using highly skilled technicians or engineers to carry out very simple maintenance tasks is not cost effective. If operators could be trained to carry out these basic tasks, it gives them an opportunity to increase their skill level, makes them more responsible for the operation of the tool, increases their job prospects, and frees up the technicians to work on more complex tasks including TPM teams. It also has the benefit that the $ cost to do the job is reduced.

Just as operators wash their own cars and check for damage, this pillar is intended to increase operators skill to a level where they are able to carry out the basic maintenance on their own equipment. By adopting “clean and inspect” procedures, they are taught to recognize abnormal operation and identify problems that are developing. Through time, as the operators’ skill improves, the AM teams will progress to more complex maintenance. They might even be capable of transferring to a technician grade.

3.1.4 Planned Maintenance (PM)

Planned Maintenance looks for the underlying causes of equipmentproblems and identifies and implements root-cause solutions.

In many organizations maintenance is rarely managed, with the engineers choosing the jobs they want to tackle and using their own experience to carry out the work. Most technicians I know dislike routine maintenance as it is too repetitive and is not a challenge.

Besides, the best wages go to the firefighters: the ones who come to the rescue when the tool crashes. There are even technicians who are the company’ s experts on the problems that happen every week! They are so good at resolving the issues that they still happen every week. Some people do not appreciate that recurring faults are unresolved faults. The technical term for firefighting is Reactive Maintenance or it would be if the problem was actually repaired on failure.

I dislike the term firefighting. It is an inappropriate name designed to glamorize a bad maintenance practice. When firemen put out fires, the fires do not usually return. Equipment breakdowns frequently do. Time after time, we see the same issues! If a fireman does not put out the fire properly, there is nothing left to return to. So, does this mean that putting out the fire is the root-cause fix for a fireman? Not a chance! When the fire is out, the fire department will search the ashes and continue to investigate until it discovers the root-cause of the fire. Even at this point the task is not over. Action is taken to learn from the findings and to circulate what has been learned to all the other fire departments. The fire department even passes on its knowledge to government offices and visits companies to teach them what it has learned about fires. In short, the firefighter strives to prevent fires from happening in the first place. This is the purpose of the PM pillar: to prevent breakdowns. It is no surprise to discover that good maintenance (and productivity) follows the same practices and high standards as the fire department. How, then, can we use the same principles to improve maintenance standards? Simple, we adopt TPM. The PM pillar covers all aspects of equipment analysis and improvement in a nice, simple way.

Where the core of an AM team is operators that have a dedicated technical supervision and a support network, Planned Maintenance teams are cross-functional and are known as Zero Fails (ZF) teams. ZF teams include operators and technicians. In addition to the basic problems covered by AM teams, the ZF teams also tackle the more complex issues. These include the effectiveness of current maintenance, eliminating recurring problems, and improving equipment efficiency. Overall Equipment Efficiency (OEE) is the measure used by TPM to attain the best equipment performance.

3.1.5. Quality Maintenance

Even what is regarded as a perfect tool will not produce perfect product. There will always be some kind of variation in the quality or the physical attributes of the product. The cause of the variation is the limitations in the equipment design and the choice of the components used. This pillar utilizes cross-functional teams to analyze areas of equipment performance where the product variation should be reduced.

Once a cause has been found, the team would investigate if a modification or an upgrade might be implemented to increase yield. Alternatively, it could search for a different manufacturing process that might not exhibit the same limitations.

3.1.6 Focused Improvement

There will be outstanding issues with equipment or processes that have been difficult to identify in the past. Cross-functional teams are used to investigate the issues and to find permanent solutions. The problems under consideration have to be evaluated to justifyif a fix would provide a positive, cost-effective benefit.

3.1.7 Support Systems

Every department within an organization has an impact on production: stores, purchasing, facilities, quality control, scheduling, goods in, office staff, and sales. Have I missed any? This pillar uses TPM techniques to identify and resolve problems.

The problems might manifest as problems like a lack of spares,incorrect spares, excessive lead times, poor quality materials, lack of standardization of dimensions of materials, parts shipped with the wrong specification, parts not arriving on time or arriving in Goods In but no one passing on the information. . . .

There are a huge number of issues. Basically, we look for problemsand then apply the TPM procedures to analyze and then eliminate them.

3.1.8 Initial Phase Management

This is the organizational or planning pillar. Teams are set up toconsider every stage of production.

The methodology follows a kind of Value Flow Analysis. How does the company get the ideas for new products? How does it make the selection of and design of new products? How can the customers' needs and wants be better served? When the customer approaches the company, is the call handled efficiently? What about the stages between the call and the product being shipped? Is the documentation necessary and effective? Is the billing correct? Does the customer get the goods as promised and when promised?

Another area covered is intended to improve the manufacturability of the produ ct. Is it easy to make? Can it be assembled the wrong way or are the parts made Poke Yoke and so only fit together in one way? Is it reliable? Is it easy to maintain? Is it easy to operate? Is the machine efficient from an energy and efficiency perspective? Does it have a low cost of ownership?

The team must investigate the complete system from start to end and look for ways to make improvements. (Borris, 2006).

4. The Impact of TPM.

TPM can be considered as the medical science of machines. TPM is a maintenance program which involves a newly defined concept for maintaining plants and equipment. The goal of the TPM program is to markedly increase production while, at the same time, increasing employee morale and job satisfaction.

TPM brings maintenance into focus as a necessary and vitally important part of the business. It is no longer regarded as a non-profit activity. Down time for maintenance is scheduled as a part of the manufacturing day and, in some cases, as an integral part of the manufacturing process. The goal is to hold emergency and unscheduled maintenance to a minimum. (Venkatesh 2007)

4.1 Maintenance cost.

Various financial studies showed U.S. companies were spending over 600 billion dollars on maintenance and related expenditures in 1990. Of this huge amount, approximately one third was unnecessary or wasted. This waste provides a cost advantage, that companies can ill afford to give to their international competitors.

Where are the wastes? They are in the ineffective use and control of maintenance resources, labour and material. For example , what is the percentage of time that a maintenance technician is involved on actual hands on activities? Is it two hours out of eight? Three hours? In companies where reactive or emergency types of maintenance make up 50% or more of maintenance workload, technicians avarage only 2 hours on hands on activities per day. During the rest of their time, they are engaged in non productive activities such as looking for parts, drawings, instructions or authorization.

What about inventory wastes? The cost of having too many spares is paid, not only in capital investments, but also in carrying costs, storage costs and labour costs. Still other costs, include spoilage costs, pilferage costs and the costs of of damage caused by materials being storesd and moved frequently.

A recent survey of maintenance and maintenance related personnel showed organisational issues, that were impacting maintenance efficiency and effectiveness.

These areas include:

Maintenance scheduling.

Hiring and training maintenance technicians.

Too much emergency or breakdown maintenance.

Lack of controls over maintenance spares.

Lack of upper management support and understanding.

Each of these problems are difficult to solve, but when combined provide any manager with a formidable task. However, organizations, that have these problems will have almost impossible task trying to implement a TPM program. The right step is to solve some of these basic problems first, before tackling the task of implementing TPM. Later will show methodology how to solve these problems.

4.2 Maintenance budget.

Maintenance budgeting is also another problem for organizations. Many methods are used to budget and monitor maintenance. While some work well, others are burdrns to maintenance departments. An extreme case occurs when maintenance is responsible for all maintenance incurred expenses, whether these expenses are requested or approved by maintenance or operations. In such cases, maintenance may or may not be in control of the moneys being spent. At the opposite end of the spectrum is the organization with a zero maintenance budget. All charges, including an overhead multiplier are billed directly to the department requesting the work or which is owns the equipment. In this case, the operations or facility organization will want to keep the maintenance cost as low as possible and will defer repairs, improvements and refurbishes that should have been performed. In either case, the primary consideration, which is the condition of company`s capital assets is pushed into the background. Total Productive Maintenance`s focus on the equipment and facility pays tremendous benefits to the company.

Figure 2, highlights the cost and payback for maintenance versus the company cost. Maintenance costs are between 15% and 40% of the total cost of production in typical manufacturing. The average is approximately 28%, an amount that is too high. When maintenance costs are reduced, even by as little as 10%, any cost avoidance is transformed directly into pretax profit. Some companies are able to save as much as 50% of their maintenance budget without sacrificing efficiency or quality of the maintenance work completed. Such savings, which increase pretax profit considerably, allow companies to be even more competitive in their respective markets. The comparative savings is highlighted in Figure 3.

These savings are enough of an enticement for some companies, but the true cost savings is yet to come. Consider which is The maintenance cost of a repair or the cost of lost production? One survey showed that this costs ranges from 2:1 to as high as 15:1, as shown in Figure 4. Therefore, if the maintenance cost for a repair is $10,000, the true cost to the company of not having the maintenance work performed ranges from $30,000 to $160,000. It is critical that companies examine the true cost of maintenance versus non-maintenance if they are ever to be successful in improving maintenance and implementing TPM.

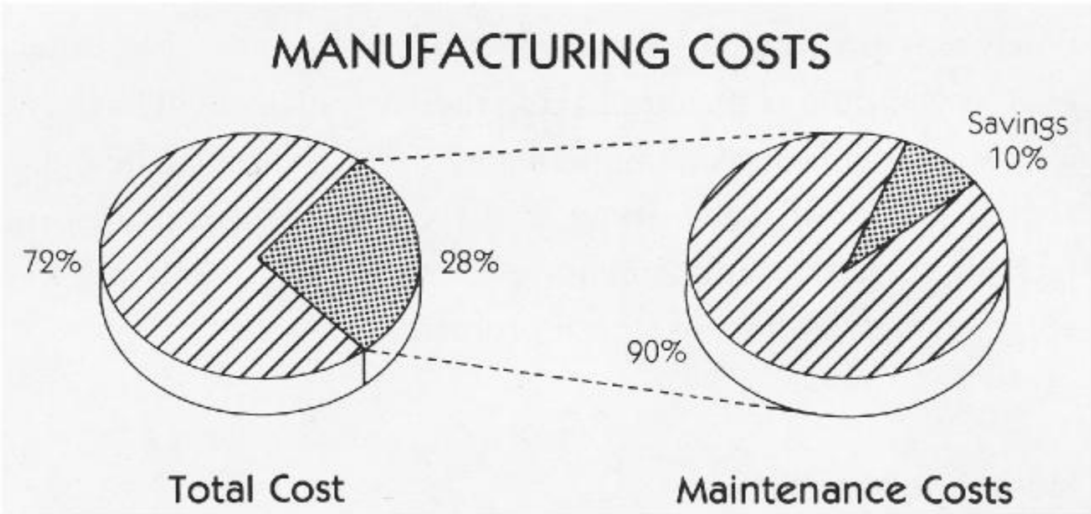

Fig. 2. Reducing maintenance costs is producing an increase in pretax profit (Wiremann, 2004)

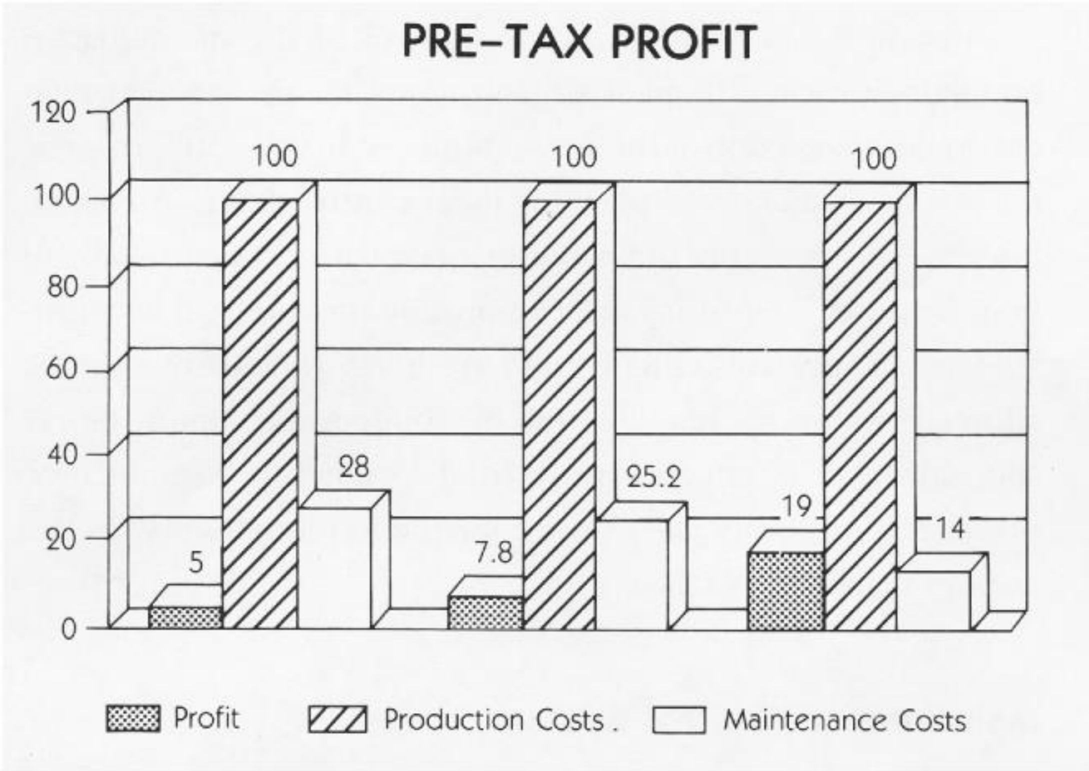

Fig. 3. The relationship between reduced maintenance costs an increase in pretax profit. (Wiremann, 2004)

An additional problem is the control of the maintenance budgeting process. In over half of the sites, the plant manager or the plant engineer controls the maintenance budget, preventing the maintenance managers from controlling the departments they are responsible and held accountable for managing (see Figure 5). Unless managers are allowed to control their department budgets, they cannot be responsible for effectiveness. Total Productive Maintenance places responsibility and control for the job functions with the correct managers.

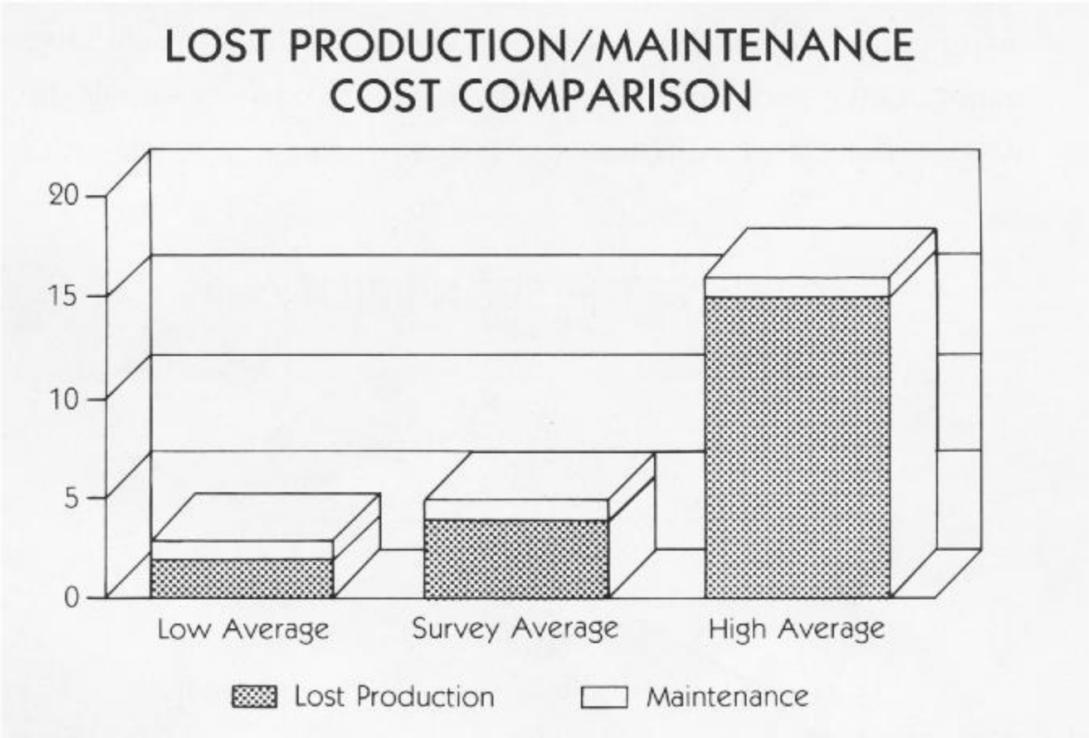

Fig. 4. Lost production costs and maintenance costs comparison. (Wiremann, 2004)

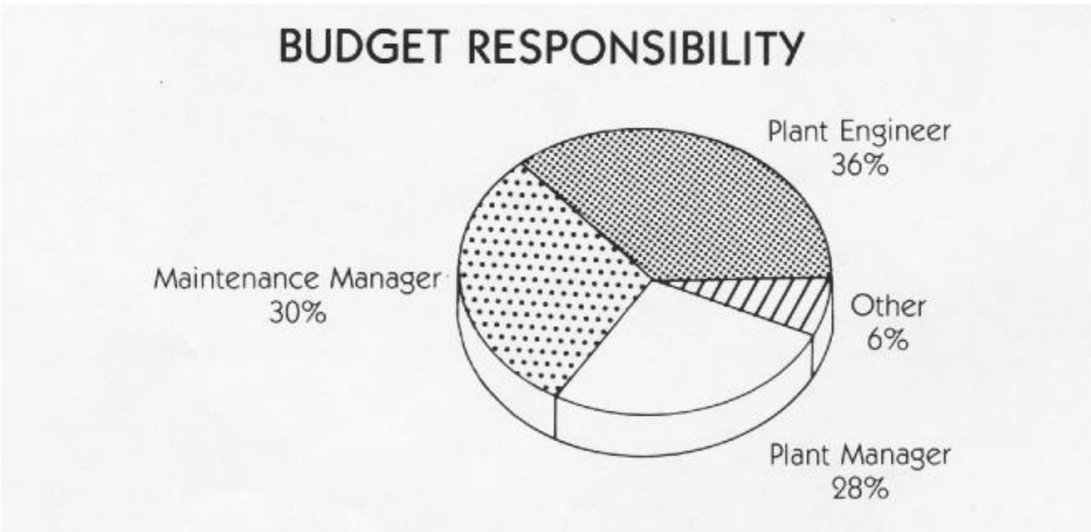

Fig. 5. Control of the maintenance budgeting process. (Wiremann, 2004)

4.3 Maintenance Control Systems

This problem area contributes to all aspects of maintenance and is a key component of a successful TPM program. It is the system used by maintenance to gather information and provide an engineering database to make accurate and cost effective maintenance decisions. The more common name for this system is the work order. Most companies claim to have a work order system. However, only a minority of the companies are satisfied with their information, a point highlighted in Figure 6, which shows that the basic information-gathering function in most maintenance organizations is not functioning properly. If the information is not being gathered properly, one must question the accuracy of the decisions that are being made based on this information.

Companies that accurately gather information on work order systems still fail to use it correctly, showing a lack of performance monitoring and information analysis (see Figure 7). Thus, even when companies do gather the information, they fail to use it to find and implement cost effective asset management decisions.

Beyond the asset management issue, consider maintenance staff sizes. The size of a maintenance workforce is determined by the amount of work that it has to perform. This amount, commonly called the craft backlog, is the accumulated total of all estimated la bor requirements on work orders waiting to be performed. Because many companies do not plan and estimate work orders, they do not know the size of their maintenance backlogs (see Figure 8). How do they then make justifiable decisions on maintenance staffing levels? It would be unimaginable for a production department to be managed in the same manner. You would either have operators standing around or equipment setting idle without an operator. This area must be controlled if optimum use of resources is to be realized.

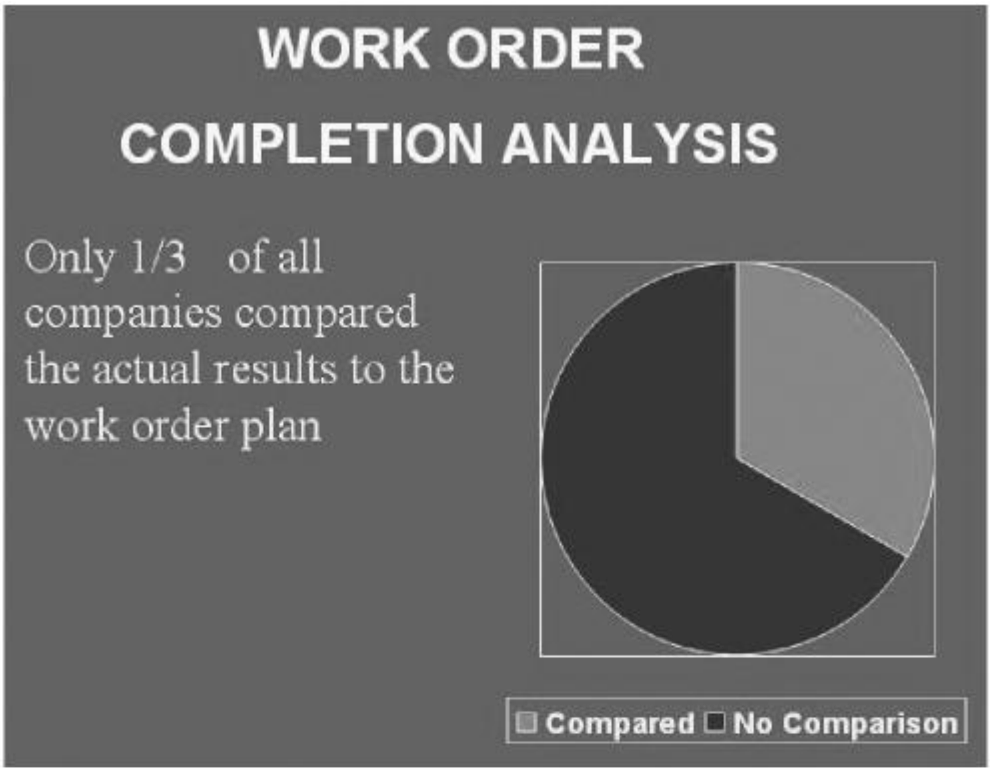

Fig. 6. Work order system analysis. (Wiremann, 2004)

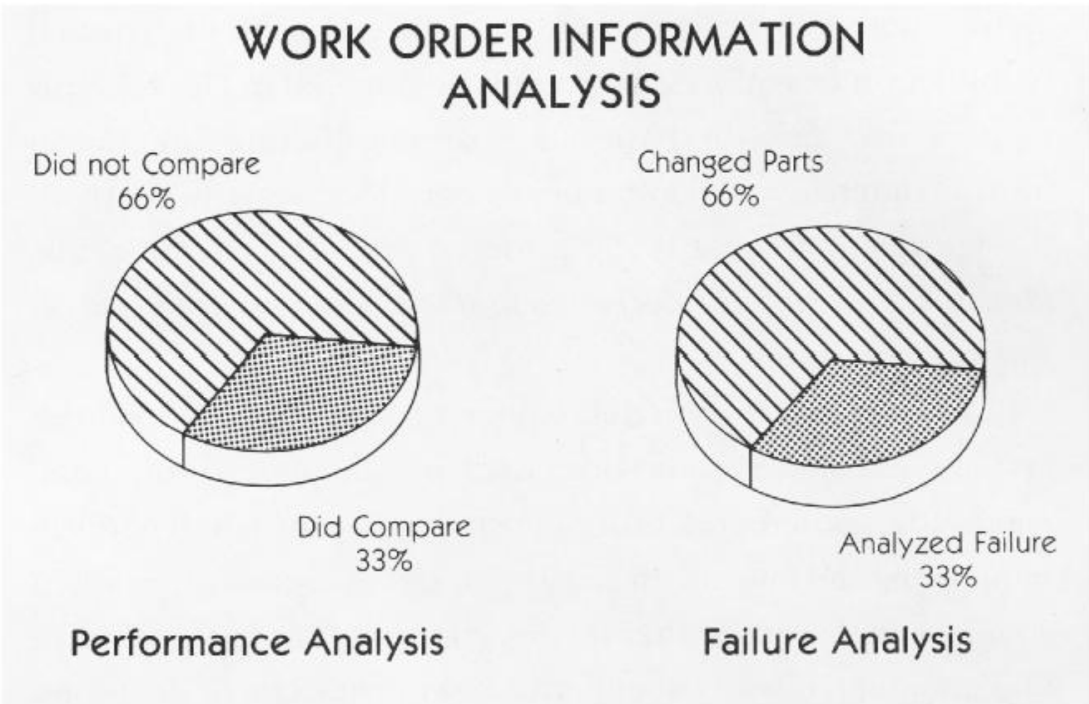

Fig. 7. Work order information analysis. (Wiremann, 2004)

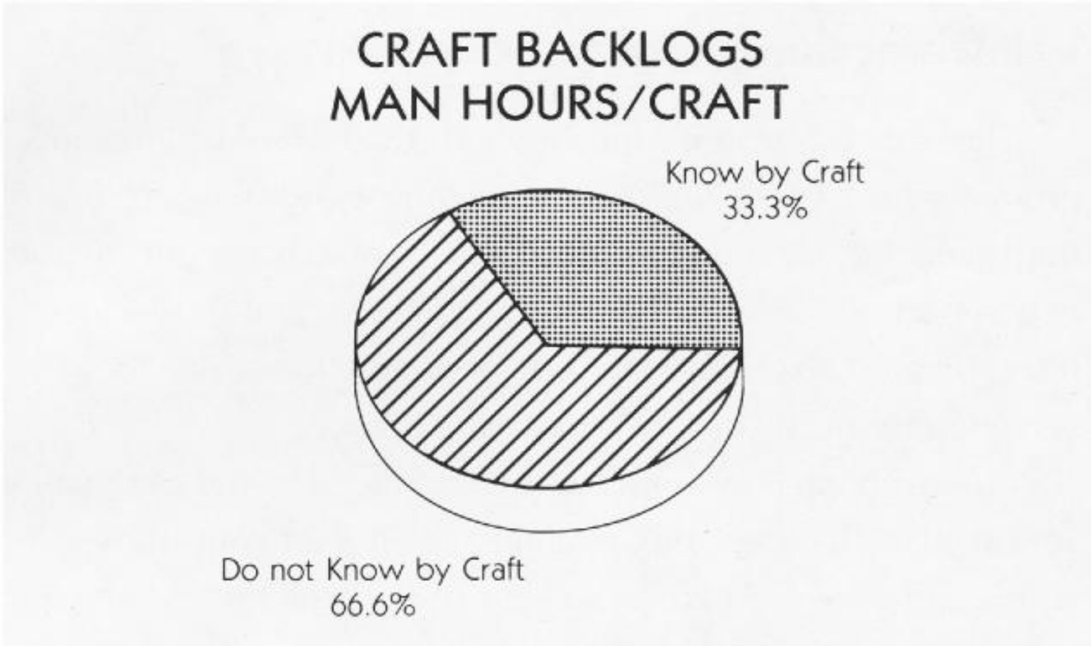

Fig. 8. Estimations of work orders. (Wiremann, 2004)

4.4 Preventive Maintenance

Preventive maintenance is another major area that must be investigated during a TPM development plan. How do U.S. companies perform preventive maintenance? Almost 80% of the companies are not satisfied that their programs work or are cost effective (see Figure 9). The main reasons for these failures and the solutions will be discussed in PM explanation. However, the largest reason for the failure of preventive and predictive maintenance programs is the lack of understanding and support for the program by upper management. Total Productive Maintenance programs ensure this support. Preventive maintenance under a TPM program will be successful if they are properly designed and implemented.

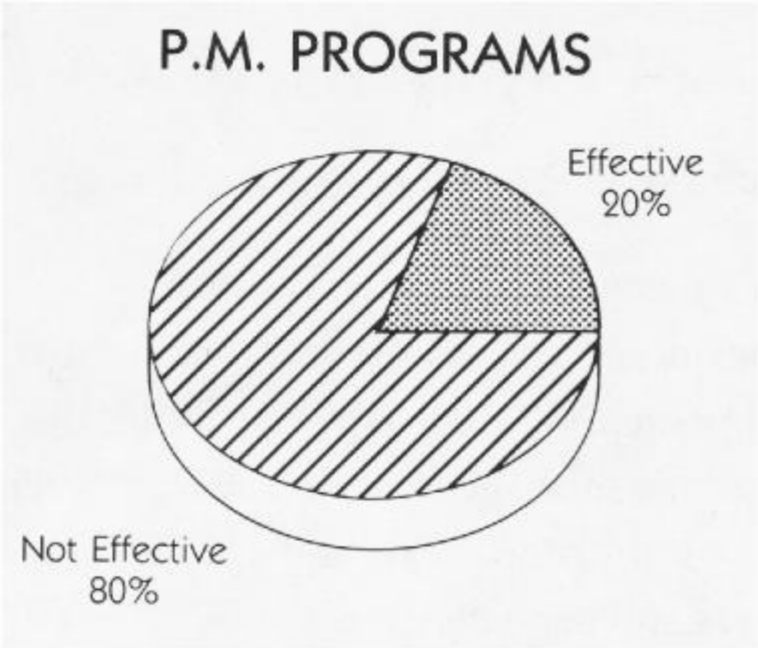

Fig. 9. Effectiveness of Preventine Maintenance programmes. (Wiremann, 2004)

4.5 Maintenance Inventory and Purchasing

This area is a major contributor to the lack of maintenance pro-ductivity in the United States. The time wasted while trying to find parts for maintenance technicians makes up one of the largest portions of the lost productive time already discussed. Estimates suggest that over 50% of all lost maintenance productivity is related to inventory and purchasing practices.

This problem is even further compounded by the fact that in al-most half of all companies, maintenance has no control, or even input, over its inventory and purchasing policies. Therefore, order policies and storage policies are made by individuals who may not understand how maintenance inventory is different from operations or production inventory. This lack of understanding creates stockouts and overstocks, both of which are unnecessary expenses that weaken an organizations competitive position. While a stockout is considered a nuisance to maintenance, what is its true cost? What is the cost of downtime or lost production that is caused by a stockout? This cost can be considerable, yet it is rarely a factor considered in stocking decisions — a major flaw in many company’s main-tenance inventory and purchasing functions.

4.6 Can We Approach TPM by Another Way ?

Many companies are asking themselves if there is more than one way to approach TPM. Experts from around the world acknowledge problems implementing a cookbook-style TPM in any company due, in part, to factors such as:

Skill of the workforce

Age of the workforce

Complexity of the equipment

Age of the equipment

Company culture

Current status of the maintenance program

Remember that the primary focus of TPM is the constant improvement in the overall equipment effectiveness (OEE) of the company’s equipment and capital assets.

The steps necessary to develop a TPM program must be determined for each company individually. These steps must be adjusted to fit individual requirements because the types of industry/ service/facility, production methods, service activities, equipment conditions, special needs, problems, techniques, and levels of sophistication of maintenance vary dramatically from organization to organization.

Thus, there is no one right answer. The focus of any TPM program is the achievement of the five basic goals discussed earlier in this chapter as well as any others that may be identified by your the particular organization. Although there is no one fixed methodology for implementing TPM, some guidelines can be examined from a technical perspective. These guidelines are presented in a flowchart format in the next section.

4.7 TPM Decision Tree

Good, sound maintenance practices are essential for effective TPM. But what exactly are good, sound maintenance practices?" The following discussion explains each block of the TPM decision tree designed to assist in the development of a TPM implementation methodology. These activities are not intended to be a cookbook, but rather to serve as a general model. If a clear understanding of the model is developed before attempting to implement TPM, then the implementation process will take less time and fewer resources.

4.7.1 PM Program Development

Preventive maintenance is the core of any equipment maintenance process improvement strategy. All plant equipment, including special back up or redundant equipment, must be covered by a complete, cost-effective preventive maintenance program. The preventive maintenance program is designed to eliminate all un-planned equipment failures.

4.7.2 Evaluation of PM Program

Evaluating the preventive maintenance program insures proper coverage of the critical equipment of the plant or facility. The program should include a good cross section of the following:

Inspections

Adjustments

Lubrication

Proactive replacements of worn components

The program should support the goal of no unplanned equipment downtime.

4.7.3 Effectiveness of PM Program

The effectiveness of the preventive maintenance program is determined by the level of unplanned equipment maintenance that is performed. Unplanned equipment maintenance is defined as any maintenance activity that is performed with less than one week of advanced planning. Unplanned equipment maintenance is commonly referred to as reactive maintenance.

An effective preventive maintenance program will reduce the amount of unplanned work to less than 80% of the total labor expended for all equipment maintenance activities. If more time is being spent on unplanned activities, then a reevaluation of the preventive maintenance program is required. It will be difficult to make progress in any of the following areas unless the preventive maintenance program is effective enough for the equipment maintenance to meet the 80% / 20% rule.

4.7.4 Maintenance Stores Revision

Once the preventive maintenance program is effective, the equipment spares, inventory, and purchasing systems must be analyzed. The equipment spares and inventory should be organized, with all of the spares identified and tagged, then stored in an identified location, with accurate on-hand and usage data. The purchasing system must allow for procurement of all necessary spare parts to meet the maintenance schedules. All data necessary to track the cost and usage of all spare parts must be complete and accurate.

4.7.5 Maintenance Stores Effectiveness

Simply defined, the service level measures the percent of time that a part or in stock when it is requested. The spare parts must be on hand at least 95% of the time for the stores and purchasing systems to support equipment maintenance activities. Unless maintenance activities are proactive (less than 20% unplanned weekly), the stores and purchasing groups cannot be cost effective in meeting equipment maintenance spare parts demands. However, the inventory and purchasing functions must achieve at least a 95% service level before effective work order utilization can occur.

4.7.6 Work Order System Review

The work order system is designed to track all equipment main-tenance activities. The activities can be anything from inspections and adjustments to major overhauls. Any maintenance that is performed without being recorded in the work order system will be lost. In turn, lost or unrecorded data makes it impossible to perform any analysis of equipment problems. All activities performed on equipment must be recorded to a work order by the responsible individual. This step highlights the point that maintenance, operations, and engineering will be extremely involved in utilizing work orders.

4.7.7 Utilization of the Work Order System

This question should be answered by performing an evaluation of the equipment maintenance data. The evaluation can be as simple as answering the following questions:

How complete is the data?

How accurate is the data?

How timely is the data?

How usable is the data?

If the data is not complete, it will be impossible to perform any meaningful analysis of the equipment's historical and current condition. If the data is not accurate, it will be impossible to correctly identify the root cause of any equipment problems. If the data is not timely, then it is impossible to correct equipment problems before they cause equipment failures. If the data is not usable, it will be impossible to format it in a manner that allows for any meaningful analysis. Unless the work order system provides data that passes this evaluation, further progress will be impossible.

For example, consider team problem-solving activities that are focused on improving overall equipment effectiveness. The teams always look for the root causes of problems that impact the OEE. Without accurate data from the work order, how can they perform a root cause analysis? How can they identify the top ten problems that cause downtime on the equipment? How would they know which modifications have been done to the equipment in the past that could have caused the current problem? Without data, all decisions about the equipment become subjective.

4.7.8 Review of Planning and Scheduling

This review examines the planning and scheduling policies and practices for equipment maintenance. The goal of planning and scheduling is to optimize any resources expended on equipment maintenance activities, while minimizing the interruption the activities have on the production schedule. The goal of planning and scheduling is to insure that all equipment maintenance activities occur like a pit stop in a NASCAR race. This insures optimum equip-ment uptime, with quality equipment maintenance activities being performed. Planning and scheduling pulls together all of the activities (maintenance, operations, and engineering), and focuses them on obtaining maximum quality results in a minimum amount of time.

4.7.9 Effectiveness of Planning and Scheduling

While this step is similar to Step 3, its focus is on the effectiveness of the activities performed in the 80% planned mode. An effective planning and scheduling program will insure maximum productivity from those employees performing any equipment maintenance activities. Delays, such as looking for parts, rental equipment, draw-ings, or tools, or waiting while equipment is shut down, will all be eliminated. If these delays are not eliminated through planning and scheduling, then optimizing equipment utilization will be impossible. It will be equivalent to a NASCAR pit crew taking too long for a pit stop; the race is lost by not keeping the car on the track. Equipment utilization is lost by not properly keeping the equipment in service.

4.7.10 Computerization of the Work Order System.

A considerable volume of data is generated and tracked to properly utilize the work order system and to plan and schedule effectively. If the data becomes difficult to manage using manual methods, it may be necessary to computerize the work order system. If the workforce is burdened with excessive paper work or is accumulating file cabinets of equipment data that no one has time to look at, then it is best to computerize the work order system. However, if the number of pieces of equipment is relatively small and data tracking and analysis are not a burden, then it may be best to maintain the manual work order system.

4.7.11 Establishing Manual Equipment Maintenance System.

A manual system can be as simple as a cardex file with cards for each equipment item, and with notations of all repairs and services on the cards. Other methods include a visual white board with markers and spaces for notations or a magnetic board with tags that can be moved as each service is complete. Still another method is a log book, which may simply be a three-ring binder, with pages for notations of each service or repair that is performed on the equipment. It does not matter which method is used, but rather that the equipment data is complete and in a format that can be analyzed.

4.7.12 Effectiveness of Manual Equipment Maintenance System.

The manual system should meet the equipment management information requirements of the organization. Some of these requirements include:

Complete tracking of all repairs and service The ability to develop reports, for example:

Top ten equipment problems

Most costly equipment to maintain

Percent reactive vs. proactive maintenance Cost tracking of all parts and costs

If the manual system does not produce this level of data, then it needs to be re-evaluated.

4.7.13 Evaluation of Manual Work Order Process

The goal of reevaluating the manual work order system is to de-termine where the weaknesses are in the system so that they can be corrected and good equipment data can be collected. Several questions for consideration include:

Is the data we are collecting complete and accurate? Is the data collection effort burdening the work force? Do we need to change the methods we use to manage the data?

4.7.14 Do we need to re-evaluate the computerization decision?

Once problems are corrected and the equipment management information system is working, then constant monitoring for problems and solutions must be put into effect.

4.7.15 Purchasing and Implementation of CMMS (EMIS)

The computerized maintenance management system (CMMS), also known at times as an Equipment Management Information System (EMIS), is a computerized version of a manual system. There are currently over 200 commercially produced CMMSs in the North American market. Finding the correct one may take some time, but through the use of lists, surveys, and word of mouth, and by evaluating the vendor's financial status, it should take no more than three to six months for any organization to select a CMMS. Once the right CMMS is selected, it must then be implemented. CMMS implementation may take from three months for smaller organizations to as long as 18 months for larger organizations to implement.

Companies can spend much time and energy addressing CMMS selection and implementation. Keep in mind that CMMS is only a tool to be used in the improvement process; it is not the goal of the process. Losing sight of this fact can curtail the effectiveness of any organization's path to continuous improvement.

4.7.16 Effectiveness of CMMS Usage

If the correct CMMS is selected, then it makes the equipment data collection faster and easier. It should also make the analysis of the data faster and easier. The CMMS should assist in enforcing World Class maintenance disciplines, such as planning and scheduling and effective stores controls. The CMMS should provide employees with usable data with which to make equipment management decisions. If the CMMS is not improving these efforts, then the effective usage of the CMMS needs to be evaluated. Some of the problems encountered with CMMS include:

Failure to fully implement the CMMS Incomplete utilization of the CMMS Inaccurate data input into the CMMS

Failure to use the data once it is in the CMMS

4.7.17 Investigation of Operators Involvement

As the equipment management system (CMMS, EMIS) becomes effective, it is time to investigate whether operator involvement is possible in some of the equipment management activities. There are many issues that need to be explored, including the types of equipment being operated, the operators to equipment ratios, the skill levels of the operators, and contractual issues with the employees' union. In most cases, there is some level of activity at which the operators can be involved within their areas. If there are no obvious activities for operator involvement, then a reevaluation of the activities will be necessary.

4.7.18 Identify the Activities of Operators

The activities in which the operators may be involved can be either basic or complex. The complexity is determined partially by their current operational job requirements. Some of the more common tasks for operators include, but are not necessarily limited to:

Equipment Cleaning - This activity may be as simple as wiping off the equipment when starting it up or shutting it down.

Equipment Inspecting - This activity may range from a visual inspection while wiping down equipment to a maintenance inspections checklist utilized while making operational checks.

4.7.19 Initiating Work Requests

Operators may prepare work requests for any problems (either current or developing) on their equipment. They pass these requests on to maintenance for entry into the work order system. Some operators will directly input work requests into a CMMS.

4.7.20 Visual Systems

Operators may use visual control techniques to inspect their equipment and to make it easier determine its condition.

Whatever the level, operator involvement should contribute to the improvement of the equipment effectiveness.

4.7.21 Are the Operators Certified to Perform the Activities?

Once the activities in which the operations personnel are to be involved have been determined, the operators skills to perform these activities need to be evaluated. The operators should be properly trained to perform any assigned tasks. The training should be developed in both written and visual formats. Once the operators are trained, copies of the materials should be given to the operators for their future reference. These materials will contribute to the commonality required in order for operators to be effective while performing these tasks. In addition, certain regulatory organizations require documented and certified training for all employees (e.g., Lock Out Tag Out).

4.7.22 Operators Involvement

Once the operators are trained and certified, they can begin performing their newly assigned tasks. The operators must be coached for a short time to insure they have the full understanding of all aspects of the new tasks. Some companies have made this coaching more effective by having the maintenance personnel assist with it. Background knowledge can then be transferred to the operators information that they may not have received otherwise during the more formal training.

4.7.23 Performing of PDM

Once the operators have begun performing some of their new tasks, maintenance resources may become available for other activities. One area that should be explored is predictive maintenance. Fundamental predictive maintenance techniques include:

Vibration Analysis

Oil Analysis

Thermography

Sonics

Plant equipment should be examined to see if any of these tech-niques will help reduce downtime and improve service. Pre-dictive technologies should not be utilized because they are technically advanced, but only when they contribute to improving the equipment effectiveness. The correct technology should be used to trend or solve the equipment problems encountered.

4.7.24 Reliability Engineering

Reliability Engineering is a broad term that includes many engineering tools and techniques. Some common tools are:

Life Cycle Costing. This technique allows companies to know the cost of their equipment from when it was designed to the time of disposal.

(RCM). Reliability Centered Maintenance is used to track the types of maintenance activities performed on equipment to insure that they are the correct activities to be performed.

(FEMA). Failure and Effects Mode Analysis examines the way the equipment is operated as well as any failures incurred during the operation in order to find methods of eliminating or reducing the numbers of failures in the future.

(EEMD). Early Equipment Management and Design. This technique takes information on equipment and feeds it back into the design process to insure that any new equipment is designed for maintainability and operability.

Using these and other reliability engineering techniques im-proves equipment performance and reliability and, in turn, helps to insure competitiveness.

4.7.25 Financial Optimization

Once the equipment is correctly engineered, the next step is to understand how the equipment or process impacts the financial aspects of the company’s business. Financial optimization considers all costs impacted when equipment decisions are made. For example, when calculating the timing to perform a preventive maintenance task, are the cost of lost production or downtime considered? Are wasted energy costs considered when cleaning heat ex-changers or coolers? In this step, the equipment data collected by the company are examined in the context of the financial impact they have on the company’s profitability.

If the data exists and the information systems are in place to continue to collect the data, then financial optimization should be utilized. With this tool, equipment teams will be able to financially manage their equipment and processes.

4.7.26 Are the Tools and the Data Available for Financial Optimization?

While financial optimization is not a new technique, most companies do not properly utilize it because they do not have the data necessary to make the technique effective. Some of the data required includes:

MTBF (Mean Time Between Failure) for the equipment MTTR (Mean Time To Repair) for the equipment Downtime or lost production costs per hour A Pareto of the failure causes for the equipment Initial cost of the equipment

Replacement costs for the equipment

Complete and accurate work order history for the equipment

Without this data, financial optimization cannot be properly conducted on equipment. Without the information systems in place to collect this data, a company will never have the accurate data nec-essary to perform financial optimization.

4.7.27 Evaluate the Success of the TPM Program

Are the results achieved by maintenance reaching the goals that were set for the improvement program when it was started? If not, then the maintenance improvement program needs to be examined for gaps in performance or deficiencies in existing parts of the process. Once weaknesses are found, then steps should be taken to correct or improve these areas.

4.7.28 Strive for Continuous Improvement

Continuous improvement means never getting complacent. It calls for constant self examination with the focus on how to become the best in the world at the company's business.

4.8 Pitfalls for TPM

While the TPM flow appears to be easy to follow, there are hidden pitfalls when trying to implement TPM.

4.8.1 Organizational Downsizing

In the business environment of the early 2000s, much of management focus is spent on headcount reductions or downsizing of the workforce. This practice is detrimental to the employee involvement required by TPM. In some companies, TPM starts as a middle management activity. The line employees buy in to the common sense approach to TPM and begin to contribute ideas that increase productivity. Because senior management has never been properly educated about the process, they use the increase in productivity (output) to focus on reducing expenses to further increase profits. When this occurs, the employee involvement required by TPM diminishes and the TPM strategy fails.

In the January 14, 1995 issue of the Economist, it was stated that, “Even the 1980s’ most ardent adherents of quality are finding that TQM does not readily blend with wave after wave of restructuring, downsizing, and reengineering”. The article stated further “the snag is downsizing undermines a cornerstone of TQM: Employee Motivation.” If you change the acronym from TQM to TPM, you have an equally true statement. Unless the entire organization from senior management to the line employees understand the true focus of TPM which is improving equipment effectiveness the TPM effort will be destined to failure.

Senior executives today need to realize that there are two ways to decrease cost per unit.

1. Make the same number of units and reduce expenses.

2. Hold the line on expenses and make more units.

TPM, while doing both, focuses more on increasing equipment utilization and eliminating waste (reducing expenses) rather than focusing on headcount reductions. Unless this is clearly understood throughout the organization, companies will continue to struggle to implement TPM strategies.

4.8.2 Lack of Focus on Results

Many consulting organizations that teach TPM focus on its esoteric aspects. They have their clients start by cleaning their equip-ment, forming teams to discuss theoretical improvements, and creating visual systems to make the plant look better. Although these activities are a part of the overall TPM strategy, they are implemented without any tangible results. Therefore, the companies spend their physical and financial resources with little, if any, financial return on investment.

Unless all of the initiatives in TPM are tied to financial benefits or improvements, senior management support wanes over time. When the company has a particularly tight quarter financially, senior management eliminates support for strategies that are not providing an immediate return on investment. When this occurs, the plug is too easily pulled on the TPM strategies. However, in companies where all TPM initiatives are tracked and financially justified, the overall TPM strategy is supported by senior management even in the most difficult of times.

TPM is not a difficult strategy to execute. As long as it has a focus and financial justification, it will be successful.

5. Implementation of TPM in T&L Slovakia

In the next chapter of this Thesis I would like to describe the background of the TPM implemtation in Amylum Slovakia, s.r.o. (T&L Slovakia), esablished after political changes in Eastern Europe as the joint – venture company of two anglo - american multinationals, Tate & Lyle, plc and Archer Daniels Midland Company (ADM). Both of them are operating the large scale of manufacturing plants worldwide, using the most innovative process technologies. Engineering and maintenance are just following the modern and innovative processes, reaching the highest level of standards. The increasing sales demand is asking for 100 % reliable manufacturing, what is driving us to reach Better Maintenance Strategies.

5.1 Analyses of the present situation.

Analyses of the current state of the maintenance has a task the best to describe the current situation of maintenance department, to define the greatest challenges of the system of maintenance in developing countries with a view to subsequent processing of the project. In the table below (Table 1) are shown progressive steps analyzing the current state of maintenance at T&L Slovakia.

5.2 Why to implement TPM ?

TPM was introduced to achieve the following objectives. The important ones are listed below.

Avoid wastage in a quickly changing economic environment.

Producing goods without reducing product quality.

Reduce cost.

Goods send to the customers must be non defective.

Table 1, Progressive Analyzing Steps, (T&L, 2010)

Analyses of internal materials
Daily scheduling of maintenance technician
Analyses of technical documentation of process equipments
Consultins with middle technical management
SWOT analyses of maintenance
Spider analyses
Complex analyses of present maintenance situation
Evaluation of current situation of maintenance and setting the goals
Bottle necks analyses
Bottle necks in operating/process systems evaluation
Pictures of machines
Pareto analyses of down times
OEE Analyses
Analyses of down times
Analyses of maintenace budget
Analyses of maintenance costs

5.3 Similarities and differences between TQM and TPM

The TPM program closely reasembles the existing Total Quality Management (TQM) program. Many of the tools such as employee empowerment, benchmarking, documentation, etc. used in TQM are used to implement and optimize TPM. Following are the similarities between the two.

Total commitment to the program by upper level management is required in both programmes.

Employees must be empowered to initiate corrective action, and a long range outlook must be accepted as TPM may take a year or more to implement and is an on going process.

Changes in employee mind set toward their job responsibilities must take place as well.

Table 2, The differences between TQM and TPM, (T&L, 2010)

Category	**TQM**	**TPM**
Object	Quality (Output and effects)	Equipment (Input and cause)
Mains of goals	Systematize the management. It is software oriented	Employees participation and it is hardware oriented
Target	Quality for PPM	Elimination of losses and wastes.

5.4 Types of maintenance

In this subchapter on the Figure 10, I would like to present my favorite maintenance pyramid.

5.4.1 Reactive - Breakdown Maintenance :

It means that people waits until equipment fails and repair it. Such a thing could be used when the equipment failure does not significantly affect the operation or production or generate any significant loss other than repair cost.

5.4.2 Preventive Maintenance (PM)

It is a daily maintenance (cleaning, inspection, oiling and re-tightening), design to retain the healthy condition of equipment and prevent failure through the prevention of deterioration, periodic inspection or equipment condition diagnosis, to measure deterioration. It is further divided into periodic maintenance and predictive maintenance. Just like human life is extended by preventive medicine, the equipment service life can be prolonged by doing preventive maintenance.

5.4.3 Periodic Maintenance (Time Based Maintenance - TBM)

Time based maintenance consists of periodically inspecting, servicing and cleaning equipment and replacing parts to prevent sudden failure and process problems.

5.4.4 Predictive Maintenance (PDM):

This is a method in which the service life of important part is predicted based on inspection or diagnosis, in order to use the parts to the limit of their service life. Compared to periodic maintenance, predictive maintenance is condition based maintenance. It manages trend values, by measuring and analyzing data about deterioration and employs a surveillance system, designed to monitor conditions through an on-line system.

5.4.5 Corrective Maintenance

It improves equipment and its components so that preventive maintenance can be carried out reliably. Equipment with design weakness must be redesigned to improve reliability or improving maintainability

5.4.6 Maintenance Prevention

It indicates the design of a new equipment. Weakness of current machines are sufficiently studied (on site information leading to failure prevention, easier maintenance and prevents of defects, safety and ease of manufacturing) and are incorporated before commissioning a new equipment.

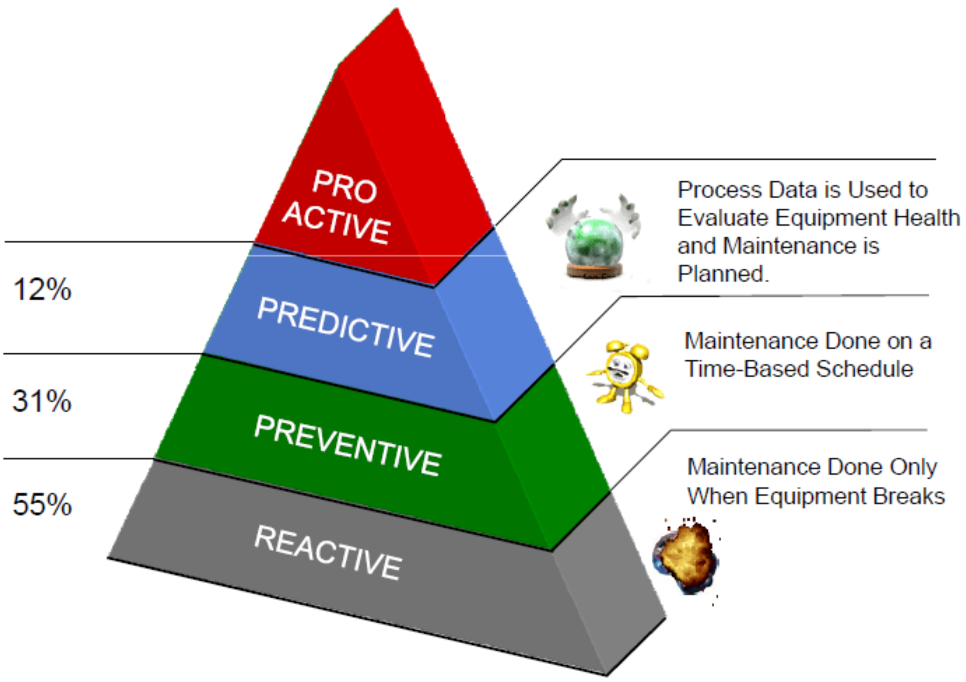

Fig. 10. Maintenance pyramid. (PlantWeb, 2011)

5.5 TPM Targets in T&L Slovakia:

Table 3, TPM Targets in T&L Slovakia, (T&L, 2010)

Motives of TPM	1. Adoption of life cycle approach for improving the overall performance of production equipment. 2. Improving productivity by highly motivated workers which is achieved by job enlargement. 3. 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 (Production operators) Operate, You (Maintenance department) fix is not followed any more.

TPM Objectives	1. Achieve Zero Defects, Zero Breakdown and Zero accidents in all functional areas of the organization. 2. Involve people in all levels of organization. 3. Form different teams to reduce defects and Self Maintenance.
Direct benefits of TPM	1. Increase productivity and OPE (Overall Plant Efficiency) by 1.5 or 2 times. 2. Rectify customer complaints. 3. Reduce the manufacturing cost by 40%. 4. Satisfy the customers needs by 100 % (Delivering the right quantity at the right time, in the required quality.) 5. Reduce accidents. 6. Follow pollution control measures.
Indirect benefits of TPM	1. Higher confidence level among the employees. 2. Keep the work place clean, neat and attractive. 3. Favorable change in the attitude of the operators. 4. Achieve goals by working as team. 5. Horizontal deployment of a new concept in all areas of the organization. 6. Share knowledge and experience. 7. The workers get a feeling of owning the machine.

OEE (Overall Equipment Efficiency) :

$$OEE = A \times PE \times Q$$

A - Availability of the machine. Availability is proportion of time machine is actually available out of time it should be available.

A = (MTBF - MTTR) / MTBF.

MTBF - Mean Time Between Failures = (Total Running Time) / Number of Failures.

MTTR - Mean Time To Repair.

PE - Performance Efficiency. It is given by RE x SE.

Rate efficiency (RE) : Actual average cycle time is slower than design cycle time because of jams, etc. Output is reduced because of jams
Speed efficiency (SE) : Actual cycle time is slower than design cycle time machine output is reduced because it is running at reduced speed.
Q - Refers to quality rate. Which is percentage of good parts out of total produced sometimes called "yield".

5.6 Steps in introduction of TPM in T&L Slovakia :

5.6.1 Preparatory Stage

STEP 1 - Announcement by Management to all about TPM introduction in the organization :

Proper understanding, commitment and active involvement of the top management in needed for this step. Senior management should have awareness programmes, after which announcement is made to all. Publish it in the house magazine and put it in the notice board. Send a letter to all concerned individuals if required.

STEP 2 - Initial education and propaganda for TPM :

Training is to be done based on the need. Some need intensive training and some just an awareness. Take people who matters to places where TPM already successfully implemented.

STEP 3 - Setting up TPM and departmental committees :

TPM includes improvement, autonomous maintenance, quality maintenance etc., as part of it. When committees are set up it should take care of all those needs.

STEP 4 - Establishing the TPM working system and target :

Now each area is benchmarked and fix up a target for achievement.

STEP 5 - A master plan for institutionalizing :

Next step is implementation leading to institutionalizing wherein TPM becomes an organizational culture. Achieving PM award is the proof of reaching a satisfactory level.

5.6.2 Introduction Stage

This is a ceremony and we should invite all. Suppliers as they should know that we want quality supply from them. Related companies and affiliated companies who can be our customers, sisters concerns etc. Some may learn from us and some can help us and customers will get the communication from us that we care for quality output.

5.6.3 Implementation

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 are for control of safety, sanitation as working environment.

5.6.4 Institutionalizing Stage

By all there activities one would has reached maturity stage. Now is the time for applying for PM award. Also think of challenging level to which you can take this movement.

5.7 Organization Structure for TPM Implementation

There is an TPM plant wide structure shown at Figure 11.

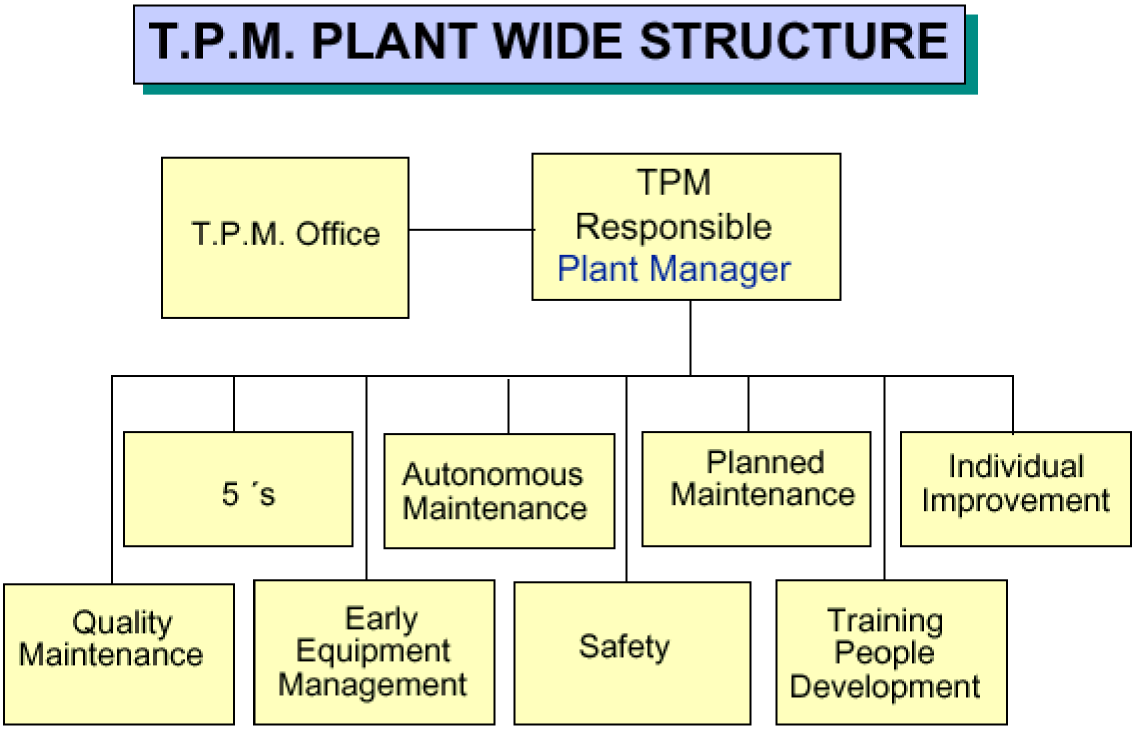

Fig. 11. Organization Structure for TPM Implementation (Venkatesh, 2007)

5.8 Pillars of TPM built on foundation of 5S.

5.8.1 PILLAR 1 - 5S

TPM starts with 5S. Problems cannot be clearly seen when the work place is unorganized. Cleaning and organizing the workplace helps the team to uncover problems. Making problems visible is the first step of improvement.

SEIRI - Sort out :

This means sorting and organizing the items as critical, important, frequently used items, useless, or items that are not need as of now. Unwanted items can be salvaged. Critical items should be kept for use nearby and items that are not be used in near future, should be stored in some place. For this step, the worth of the item should be decided based on utility and not cost. As a result of this step, the search time is reduced.

Fig. 12. Pillars of TPM built on foundation of 5S. (Venkatesh, 2007)

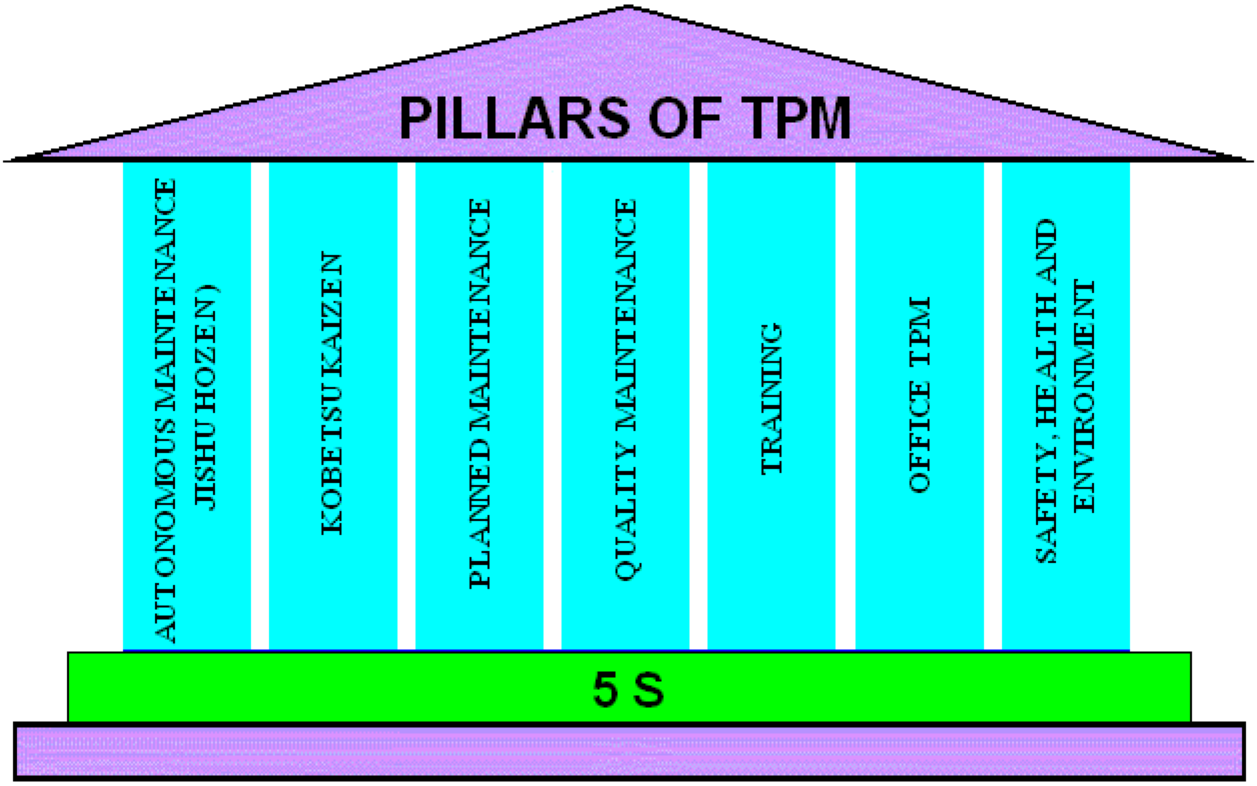

Table. 4, 5S, (Venkatesh, 2007)

Japanese Term	English Translation	Equivalent 'S' term
Seiri	Organisation	Sort
Seiton	Tidiness	Systematise
Seiso	Cleaning	Sweep
Seiketsu	Standardisation	Standardise

Shitsuke	Discipline	Self - Discipline

SEITON - Organise :

The concept here is that "Each items has a place, and only one place". The items should be placed back after usage at the same place. To identify items easily, name plates and colored tags has to be used. Vertical racks can be used for this purpose, and heavy items occupy the bottom position in the racks.

SEISO - Shine the workplace :

This involves cleaning the work place free of burrs, grease, oil, waste, scrap etc. No loosely hanging wires or oil leakage from machines.

SEIKETSU - Standardization :

Employees has to discuss together and decide on standards for keeping the work place / Machines / pathways neat and clean. This standards are implemented for whole organization and are tested / Inspected randomly.

SHITSUKE - Self discipline :

Considering 5S as a way of life and bring about self-discipline among the employees of the organization. This includes wearing badges, following work procedures, punctuality, dedication to the organization etc.

5.8.2 PILLAR 2 - JISHU HOZEN (Autonomous maintenance)

This pillar is geared towards developing operators to be able to take care of small maintenance tasks, thus freeing up the skilled maintenance people to spend time on more value added activity and technical repairs. The operators are responsible for upkeep of their equipment to prevent it from deteriorating.

Policy :

1. Uninterrupted operation of equipments.
2. Flexible operators to operate and maintain other equipments.
3. Eliminating the defects at source through active employee participation.
4. Stepwise implementation of JH activities.

JISHU HOZEN Targets:

1. Prevent the occurrence of 1A / 1B because of JH.
2. Reduce oil consumption by 30%
3. Reduce process time by 30%
4. Increase use of JH by 30%

Steps in JISHU HOZEN :

1. Preparation of employees.
2. Initial cleanup of machines.
3. Take counter measures
4. Fix tentative JH standards
5. General inspection
6. Autonomous inspection
7. Standardization and
8. Autonomous management.

Each of the above mentioned steps is discussed in detail below.

1. Train the Employees : Educate the employees about TPM, Its advantages, JH advantages and Steps in JH. Educate the employees about abnormalities in equipments.

2. Initial cleanup of machines :

    Supervisor and technician should discuss and set a date for implementing step1

    Arrange all items needed for cleaning

    On the arranged date, employees should clean the equipment completely with the help of maintenance department.

    Dust, stains, oils and grease has to be removed.

    Following are the things that has to be taken care while cleaning. They are Oil leakage, loose wires, unfastened nits and bolts and worn out parts.

After clean up problems are categorized and suitably tagged. White tags is place where problems can be solved by operators. Pink tag is placed where the aid of maintenance department is needed.

Contents of tag is transferred to a register.

Make note of area which were inaccessible.

Finally close the open parts of the machine and run the machine.

3. Counter Measures :

Inaccessible regions had to be reached easily. E.g. If there are many screw to open a fly wheel door, hinge door can be used. Instead of opening a door for inspecting the machine, acrylic sheets can be used.

To prevent work out of machine parts necessary action must be taken.

Machine parts should be modified to prevent accumulation of dirt and dust.

4. Tentative Standard :

JH schedule has to be made and followed strictly.

Schedule should be made regarding cleaning, inspection and lubrication and it also should include details like when, what and how.

5. General Inspection :

The employees are trained in disciplines like Pneumatics, electrical, hydraulics, lubricant and coolant, drives, bolts, nuts and Safety.

This is necessary to improve the technical skills of employees and to use inspection manuals correctly.

After acquiring this new knowledge the employees should share this with others.

By acquiring this new technical knowledge, the operators are now well aware of machine parts.

6. Autonomous Inspection :

New methods of cleaning and lubricating are used.

Each employee prepares his own autonomous chart / schedule in consultation with supervisor.

Parts which have never given any problem or part which don't need any inspection are removed from list permanently based on experience.

Including good quality machine parts. This avoid defects due to poor JH.

Inspection that is made in preventive maintenance is included in JH.

The frequency of cleanup and inspection is reduced based on experience.

7. Standardization :

Up to the previous stem only the machinery / equipment was the concentration. However in this step the surroundings of machinery are organized. Necessary items should be organized, such that there is no searching and searching time is reduced.

Work environment is modified such that there is no difficulty in getting any item.

Everybody should follow the work instructions strictly.

Necessary spares for equipments is planned and procured.

8. Autonomous Management :

OEE and OPE and other TPM targets must be achieved by continuous improve through Kaizen.

PDCA (Plan, Do, Check and Act) cycle must be implemented for Kaizen.

5.8.3 PILLAR 3 - KAIZEN :

"Kai" means change, and "Zen" means good (for the better). Basically kaizen is for small improvements, but carried out on a continual basis and involve all people in the organization. Kaizen is opposite to big spectacular innovations. Kaizen requires no or little investment. The principle behind is that "a very large number of small improvements are move effective in an organizational environment than a few improvements of large value. This pillar is aimed at reducing losses in the workplace that affect our efficiencies. By using a detailed and thorough procedure we eliminate losses in a systematic method using various Kaizen tools. These activities are not limited to production areas and can be implemented in administrative areas as well.

Kaizen Policy :

1. Practice concepts of zero losses in every sphere of activity.
2. Relentless pursuit to achieve cost reduction targets in all resources
3. Relentless pursuit to improve over all plant equipment effectiveness.
4. Extensive use of PM analysis as a tool for eliminating losses.
5. Focus of easy handling of operators.

Kaizen Target :

Achieve and sustain zero loses with respect to minor stops, measurement and adjustments, defects and unavoidable downtimes. It also aims to achieve 30% manufacturing cost reduction.

Tools used in Kaizen :

1. PM analysis
2. Why - Why analysis
3. Summary of losses
4. Kaizen register
5. Kaizen summary sheet.

The objective of TPM is maximization of equipment effectiveness. TPM aims at maximization of machine utilization and not merely machine availability maximization. As one of the pillars of TPM activities, Kaizen pursues efficient equipment, operator and material and energy utilization, that is extremes of productivity and aims at achieving substantial effects. Kaizen activities try to thoroughly eliminate 16 major losses.

Table 5, Major losses in an organisation, (Venkatesh, 2007)

Loss	Category
1. Failure losses - Breakdown loss 2. Setup / adjustment losses 3. Cutting blade loss 4. Start up loss 5. Minor stoppage / Idling loss. 6. Speed loss - operating at low speeds. 7. Defect / rework loss 8. Scheduled downtime loss	Losses that impede equipment efficiency
9. Management loss 10. Operating motion loss 11. Line organization loss 12. Logistic loss 13. Measurement and adjustment loss	Loses that impede human work efficiency
14. Energy loss 15. Die, jig and tool breakage loss 16. Yield loss.	Loses that impede effective use of production resources

Table 6, Classification of losses (Venkatesh, 2007)

Aspect	**Sporadic Loss**	**Chronic Loss**
Causation	Causes for this failure can be easily traced. Cause-effect relationship is simple to trace.	This loss cannot be easily identified and solved. Even if various counter measures are applied
Remedy	Easy to establish a remedial measure	This type of losses are caused because of hidden defects in machine, equipment and methods.
Impact / Loss	A single loss can be costly	A single cause is rare - a combination of causes trends to be a rule
Frequency of occurrence	The frequency of occurrence is low and occasional.	The frequency of loss is more.
Corrective action	Usually the line personnel in the production can attend to this problem.	Specialists in process engineering, quality assurance and maintenance people are required.

5.8.4 PILLAR 4 - PLANNED MAINTENANCE :

It is aimed to have trouble free machines and equipments producing defect free products for total customer satisfaction. This breaks maintenance down into 4 "families" or groups which was defined earlier.

1. Preventive Maintenance
2. Breakdown Maintenance
3. Corrective Maintenance
4. Maintenance Prevention

With Planned Maintenance we evolve our efforts from a reactive to a proactive method and use trained maintenance staff to help train the operators to better maintain their equipment.

Policy :

1. Achieve and sustain availability of machines
2. Optimum maintenance cost.
3. Reduces spares inventory.
4. Improve reliability and maintainability of machines.

Target :

1. Zero equipment failure and break down.
2. Improve reliability and maintainability by 50 %
3. Reduce maintenance cost by 20 %
4. Ensure availability of spares all the time.

Six steps in Planned maintenance :

1. Equipment evaluation and recoding present status.
2. Restore deterioration and improve weakness.
3. Building up information management system.
4. Prepare time based information system, select equipment, parts and members and map out plan.
5. Prepare predictive maintenance system by introducing equipment diagnostic techniques and
6. Evaluation of planned maintenance.

5.8.5 PILLAR 5 - QUALITY MAINTENANCE :

It is aimed towards customer delight through highest quality through defect free manufacturing. Focus is on eliminating non-conformances in a systematic manner, much like Focused Improvement. We gain understanding of what parts of the equipment affect product quality and begin to eliminate current quality concerns, then move to potential quality concerns. Transition is from reactive to proactive (Quality Control to Quality Assurance).

QM activities is to set equipment conditions that preclude quality defects, based on the basic concept of maintaining perfect equipment to maintain perfect quality of products. The condition are checked and measure in time series to very that measure values are within standard values to prevent defects. The transition of measured values is watched to predict possibilities of defects occurring and to take counter measures before hand.

Policy :

1. Defect free conditions and control of equipments.
2. QM activities to support quality assurance.
3. Focus of prevention of defects at source
4. Focus on poka-yoke. (fool proof system)
5. In-line detection and segregation of defects.
6. Effective implementation of operator quality assurance.

Target :

1. Achieve and sustain customer complaints at zero
2. Reduce in-process defects by 50 %
3. Reduce cost of quality by 50 %.

Data requirements :

Quality defects are classified as customer end defects and in house defects. For customer end data, we have to get data on

1. Customer end line rejection
2. Field complaints.

In-house, data include data related to products and data related to process

Data related to product :

1. Product wise defects
2. Severity of the defect and its contribution - major/minor

3. Location of the defect with reference to the layout
4. Magnitude and frequency of its occurrence at each stage of measurement
5. Occurrence trend in beginning and the end of each production/process/changes. (Like pattern change, ladle/furnace lining etc.)
6. Occurrence trend with respect to restoration of breakdown/modifications/periodical replacement of quality components.

Data related to processes:

1. The operating condition for individual sub-process related to men, method, material and machine.
2. The standard settings/conditions of the sub-process
3. The actual record of the settings/conditions during the defect occurrence.

5.8.6 PILLAR 6 - TRAINING :

It is aimed to have multi-skilled revitalized employees whose morale is high and who has eager to come to work and perform all required functions effectively and independently. Education is given to operators to upgrade their skill. It is not sufficient know only "Know-How" by they should also learn "Know-why". By experience they gain, "Know-How" to overcome a problem what to be done. This they do without knowing the root cause of the problem and why they are doing so. Hence it become necessary to train them on knowing "Know-why". The employees should be trained to achieve the four phases of skill. The goal is to create a factory full of experts. The different phase of skills are

Phase 1 : Do not know.

Phase 2 : Know the theory but cannot do.

Phase 3 : Can do but cannot teach

Phase 4 : Can do and also teach.

Policy :

1. Focus on improvement of knowledge, skills and techniques.
2. Creating a training environment for self learning based on felt needs.
3. Training curriculum / tools /assessment etc conductive to employee revitalization

4. Training to remove employee fatigue and make work enjoyable.

Target :

1. Achieve and sustain downtime due to want men at zero on critical machines.
2. Achieve and sustain zero losses due to lack of knowledge / skills / techniques
3. Aim for 100 % participation in suggestion scheme.

Steps in Educating and training activities :

1. Setting policies and priorities and checking present status of education and training.
2. Establish of training system for operation and maintenance skill up gradation.
3. Training the employees for upgrading the operation and maintenance skills.
4. Preparation of training calendar.
5. Kick-off of the system for training.
6. Evaluation of activities and study of future approach.

5.8.7 PILLAR 7 - OFFICE TPM :

Office TPM should be started after activating four other pillars of TPM (JH, KK, QM, PM). Office TPM must be followed to improve productivity, efficiency in the administrative functions and identify and eliminate losses. This includes analyzing processes and procedures towards increased office automation. Office TPM addresses twelve major losses. They are

1. Processing loss
2. Cost loss including in areas such as procurement, accounts, marketing, sales leading to high inventories
3. Communication loss
4. Idle loss
5. Set-up loss
6. Accuracy loss
7. Office equipment breakdown
8. Communication channel breakdown, telephone and fax lines

9. Time spent on retrieval of information
10. Non availability of correct on line stock status
11. Customer complaints due to logistics
12. Expenses on emergency dispatches/purchases

How to start office TPM ?

A senior person from one of the support functions e.g. Head of Finance, MIS, Purchase etc should be heading the sub-committee. Members representing all support functions and people from Production & Quality should be included in sub committee. TPM co-ordinate plans and guides the sub committee.

1. Providing awareness about office TPM to all support departments
2. Helping them to identify P, Q, C, D, S, M in each function in relation to plant performance
3. Identify the scope for improvement in each function
4. Collect relevant data
5. Help them to solve problems in their circles
6. Make up an activity board where progress is monitored on both sides - results and actions along with Kaizens.
7. Fan out to cover all employees and circles in all functions.

Kobetsu Kaizen topics for Office TPM :

Inventory reduction

Lead time reduction of critical processes

Motion & space losses

Retrieval time reduction.

Equalizing the work load

Improving the office efficiency by eliminating the time loss on retrieval of information, by achieving zero breakdown of office equipment like telephone and fax lines.

Office TPM and its Benefits :

1. Involvement of all people in support functions for focusing on better plant performance
2. Better utilized work area
3. Reduce repetitive work
4. Reduced inventory levels in all parts of the supply chain
5. Reduced administrative costs
6. Reduced inventory carrying cost
7. Reduction in number of files
8. Reduction of overhead costs (to include cost of non-production/non capital equipment)
9. Productivity of people in support functions
10. Reduction in breakdown of office equipment
11. Reduction of customer complaints due to logistics
12. Reduction in expenses due to emergency dispatches/purchases
13. Reduced manpower
14. Clean and pleasant work environment.

P Q C D S M in Office TPM :

P - Production output lost due to want of material, Manpower productivity, Production output lost due to want of tools.

Q - Mistakes in preparation of cheques, bills, invoices, payroll, Customer returns/warranty attributable to BOPs, Rejection/rework in BOP's/job work, Office area rework.

C - Buying cost/unit produced, Cost of logistics - inbound/outbound, Cost of carrying inventory, Cost of communication, Demurrage costs.

D - Logistics losses (Delay in loading/unloading)

Delay in delivery due to any of the support functions

Delay in payments to suppliers

Delay in information

S - Safety in material handling/stores/logistics, Safety of soft and hard data.
M - Number of kaizens in office areas.

How office TPM supports plant TPM :
Office TPM supports the plant, initially in doing Jishu Hozen of the machines (after getting training of Jishu Hozen), as in Jishu Hozen at the

1. Initial stages machines are more and manpower is less, so the help of commercial departments can be taken, for this

2. Office TPM can eliminate the lodes on line for no material and logistics.

Extension of office TPM to suppliers and distributors :
This is essential, but only after we have done as much as possible internally. With suppliers it will lead to on-time delivery, improved 'in-coming' quality and cost reduction. With distributors it will lead to accurate demand generation, improved secondary distribution and reduction in damages during storage and handling. In any case we will have to teach them based on our experience and practice and highlight gaps in the system which affect both sides. In case of some of the larger companies, they have started to support clusters of suppliers.

5.8.8 PILLAR 8 - SAFETY, HEALTH AND ENVIRONMENT

Target :

1. Zero accident,
2. Zero health damage
3. Zero fires.

In this area focus is on to create a safe workplace and a surrounding area that is not damaged by our process or procedures. This pillar will play an active role in each of the other pillars on a regular basis.

A committee is constituted for this pillar which comprises representative of officers as well as workers. The committee is headed by Plant Manager. The most importance to Safety is given in the plant. Safety officer is looking after functions related to safety. To create awareness among employees various competitions like safety slogans, Banners, Posters, Safety days, Pictograms related to safety can be organized at regular intervals.

6. Results of the thesis

Today, with competition in industry at an all time high, TPM may be the only thing that stands between success and total failure. It has been proven to be a program that works. It can be adapted to work not and in a variety of other situations. Employees must be educated and convinced that TPM is not just another "program of the month" and that management is totally committed to the program and the extended time frame necessary for full implementation. If everyone involved in a TPM program does his or her part, an unusually high rate of return compared to resources invested may be expected.

6.1 Evaluation of TPM Implementation at T&L Slovakia

TPM involves everyone in the organization, from operators to top management, in equipment improvement. Equipment improvement does not just mean incremental improvements, but also optimum utilization of the equipment.

Here I can prove, that implementation of TPM at T&L Slovakia was successful. By working with increasing the TPM pyramid completion, the maintenance efficiency also improves.

As shown on Figure 13, all departments must focus on how they impact the equipment.

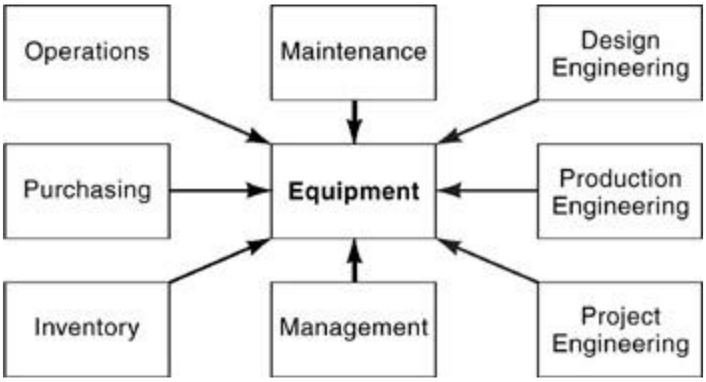

Figure 13: Focusing on TPM (ipaslovakia.sk, 2011)

6.1.1 Evaluation of Data

(As distortion factor, we have to keep in mind two projects for general production volume increasing executed during the TPM implementation and projects of mechanical vapour recompression evaporator implementation)

Productivity increasing by 38 %

Production volume increasing by 19%

Breakdowns and unscheduled downtime are less frequent and are resolved more quickly.

Non planned shut downs decreasing to 1% per month

Total shut downs decreasing to 3% per month

Overall maintenance and manufacturing costs are reduced - Maintenance budget still to be evaluated, because of production volume increasing

Utilities consumption decrease by 40 %.

Accident rates are lowered - Working 800 days without lost time accident.

Planned maintenance activities are more frequent and are incorporated into the production schedule.

A bigger focus put on the short term goal setting and the follow ups of them.

Successful CMMS implementation – SAP maintenance module

Follow up on motivation and leadership

Introdusing competition in daily work

LIST OF FIGURES AND TABLES

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