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Increased the Productivity by Total Prevention Maintenance System (TPM)

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ABSTRACT

By the increasing use of equipment machine in accelerating service activities, few people are aware of the disorder and delay that these tools cause in administrative process. Some factors that lead to customer dissatisfaction and irreparable damage to the validity of the organizations are computer bugs that cause disruption in payments, issuing commands, sending message correspondence and receiving proper financial accounts or damages to installations & machines such as computer system, heading, cooling and printing machines. For saving the expenses and optimal using of facilities & machines, managers must learn a new method of maintenance & repairing.
One of the approaches for maintenance and repairing equipment & machine corrosion, destruction and stopping equipment & machines in order to optimize and accelerate the services. For achieving this goal, Shiraz educational organization, has taken some steps for performing TPM including: organizing team work, teaching, providing 5s, preparing worksheet data record, collecting & processing data, calculating indicators, monitoring net system and doing reforming actions. This department was able to decrease the resources consumption by preventing damages to equipment & machines, also by reducing the work pressure, staff's morale, the quality of the services and customer satisfaction will be obtained. We hope that this article can optimize equipment and machines condition in enhancing the productivity of educational organizations.
KEYWORDS: preventive maintenance, monitoring worksheet, monitoring, productivity

1. INTRODUCTION

Educational organization with the most audience and customer, tends to appear as the best organization by providing best performance and getting customers attention. This organization wants to prepare suitable & fast services in desirable environment without any chemical and sound pollution that is caused by imperfect heating & cooling system, printing machines and computer systems.

To accelerate service activities, reduce human errors and increase productivity, mechanized activities with hardware and software application have been enhanced. All organizations rapidly lose their resources and capabilities unless they have a proper program for maintaining the facilities, equipment and machines.

Lack of management will lead to the rapid destruction of equipment & machines. Some complaints related to the maintenance & repairing machine system are as follows: high expenses of spare parts, early repairs due to lack of proper care , harmful effects on timely and appropriate services because of continuous and long delays of machines, unfamiliarity with the new machines, not knowing the way of maintaining & checking the equipment well, a big financial burden on organizations due to the trips of after –sale service companies , irreparable damages to the appliance until the renovation and unclear role of each person regarding the equipment [1].

It is unlikely to prevent the damages caused by the destruction of devices, but it is possible to reduce the problems, financial and credit loss by a proper planning and good management. In other words, which method can prohibit the impairment and wasting of machines & equipment?

Appropriate scientific – practical approaches for repairing & maintenance in organization have been carried out to keep the equipment, increase productivity and decrease expenses. Various methods and systems have been planned to review, adapt and localize each ones to the condition of the organization, so it makes the application easier.

One of the methods of maintenance is Total Prevention Maintenance system (TPM) which enhances the productivity and reduce the impairment of devices by operators' participation & implementing preventive controls.

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This study aims to reveal the effectiveness of TPM & its application in education with a practical sample in zone 2, Shiraz educational organization, 2009.

2. MATERIALS AND METHODS

2.1. Theory and Back ground

2.1.1. Introduction of Total Prevention Maintenance system

This process includes all activities with regards to maintain the initial condition of resources & equipment and prepare them for performing ideal services. One of the maintenance system is Total Prevention Maintenance system. Regular performance of this system is based on all staff in small group activities. The main purpose of this approach is to reach to a point not to stop the machine or decrease its speed accuracy. This will improve the efficiency and productivity of the equipment [2].

Although there are different definitions for the TPM concept, two comprehensive definitions are mentioned here including Japanese & western approaches. Japanese TPM approach is derived from a Japanese institute of maintenance. It is divided into five main sections:

1. TPM purpose is to use the equipment at the highest level of effectiveness.
2. To create a system of preventive maintenance, including preventive & improvement maintenance.
3. To have a good TPM implementation, it requires the participation of designers, users and staff of maintenance section.
4. Also, it needs the cooperation of all organizational levels from the highest to the lowest.
5. Implementation of maintenance is based on small groups and automatic activities [3].

According to Rain (1990, quoted by Zare and Moghaddami,2008)[4] with a western approach, TPM is defined as: collaboration between production, repairing and maintenance organizations in order to improve the quality, decrease waste and production expenses, increase the readiness of equipment and enhance the productivity of the organization. Zare & Moghaddami (2008) [ibid] stated that Japanese TPM definitions focus on team work & small groups activities in maintenance process, which western TPM approaches emphasize on the active cooperation of operators for better efficiency and productivity of the equipment.

As these two researchers, the ultimate goal of Japanese & western approaches is getting to a zero point of waste, accidents and destruction. Other goods of TPM presented by them are improving production, delivering the customers goods on time, creating security for operators in the office as well as boosting the staff morale.

Zare & Moghaddami [4] not only introduce the improvement branches of TPM, but also mention the crucial role of education to the users for automatic maintenance of system. Training operators will help them to increase their skill level, manage the maintenance and repairing of equipment & machines process on time, be familiar with the working system and finally the slogan "equipment without repairs" will be fulfilled [1].

Protecting devices can be done in two ways:

- With the application of protection principals to control & secure machines & tools (This technique is usually used by manufactures that make different parts of equipment. For example using local phone socket in a proper place to prevent the electricity connection by mistake).
- By following the security & protection principals by users. (For instance, removing dust and bits of paper from printing appliances).

The second method is more accepted in this study than the first one.

2.1.2 Available approaches in maintenance & repairing TPM

Organizations have different viewpoints into TPM implementation. It depends on culture & condition in different organizations. Attitude & effective methods can be created by the familiarity with these approaches. Ashrafi's opinion (2003)[5] about TPM techniques are as follows:

2.1.2.1 Emergency Maintenance

Emergency maintenance is related to the time when a device is disabled or not having a desirable function. So, this program leads to repair and replace in the minimum time. In fact, an unplanned TPM is done on equipment.

2.1.2.2 Preventive Maintenance

Preventive maintenance is a planned repairs program for devices to make the life of the device longer and to prohibit emergency or unplanned repairs activities. The crucial aim in this method is providing the expected services, actually it is treatment before occurrence. It is done before the critical point of the equipment & complete stopping of the action.

2.1.2.3 Predictive Maintenance

This TPM uses statistical analysis. It predicted the time when the preventive maintenance must be applied on machines and equipment. Thus, by performing preventive maintenance for several times, predicative maintenance will be accomplished as a result of statistical data.

2.1.2.4 Proactive Maintenance

The main purpose of proactive maintenance is on the roots of erosion and failure of machines and equipment. It attempts to eliminate the main reasons of machine destruction.

2.1.2.5 Productive Maintenance

This method involves some of the mentioned approaches . Its goal is to increase the productivity. So, all the previous techniques are utilized to reach the system to the optimal desire. In productive TPM , users protect the machines in suitable conditions and increase their awareness about the potential problems in equipment before any damage[3].

Thus, by protecting the system in a correct and complete way, staff can be released from any concerns regarding emergency & sudden damage to the equipment. In fact, a feeling of possession is created among the employees. They behave with them as their own goods. So, they pay attention to abnormal noise, vibrationand etc better than before. They check the vehicles in a good way to solve the problems before they cause any unexpected difficulties.

Although the most important aim of TPM is to improve the facilities of machines for accelerating the services and decreasing the breakdown, another goal is to provide manuals & staff's security during the performance [6].It is necessary to edit the procedures which lead to a safe & perfect environment for increasing the staff efficiency and organizational productivity.

The other purpose of this system is to eradicate six devastating factors: waste, stopping, slowness, rework and preventing the reboot of the device as one of the most important measuring indicator in productive maintenance [7].

2.2.. TPM & its procedure in Education

TPM success and productivity improvement in education depend on different factors such as supporting the senior manager, committed individuals in all levels, a measuring performance system, training staff, giving rewards, budget & expenses management, community participation, feedback and reform [8].

Management commitment is a prerequisite which should be in progress before & during the implementation of the program. Supporting the leadership, planning, performance evaluating system, process & management and above all, the continuous determination, made TPM implementation easier. The effect of staff & users is clear very well. The key factor for successful TPM is users participation in all processes from designing to performing.

Due to the support & commitment of senior managers and capable staff, the quality improvement projects in zone 2, Shiraz educational organization were done in 2008. In one of the planning meeting where managers & experts were present, the employees complain about the failure of some devices. For example, archivist mentioned the disorganized cooling system. He said the engine was fired and replaced for five times in 2 weeks. Computer system, heating & lighting were the same. Dissatisfaction with the current situation, made the managers & staff to create a dynamic organization.

Therefore, the idea of management implementation system was approved for the continuous improvement of processes & good quality to attract the customers' demands. So, they will be able to identify weak points on due time, eliminate them and improve service processes[9].

Jalali (2008)[7] proposed the following steps for TPM effectiveness:

A: determining teamwork for collecting correct data

B: collecting & processing data

C: reckoning indicators & monitoring TPM system

D: eliminating the reasons of failure by corrective or preventive action

The accomplished steps are summarized as follows:

2.2.1 Organization of working team

Following the agreement of managers and their familiarity with TPM, a working team including planning deputy, service, technology, planning and property experts was formed. These members taught and guided the other colleagues after passing the educational courses. Working team came together once every 2 weeks, reported their activities and creating the necessary cooperation between different departments.

2.2.2 Training

Training period was held based on a classified schedule & effective individuals on TPM performance. The training course consisted of making the workplace in order, familiarity with the maintenance system and with the auditing principals in TPM.

2.2.3 Providing infrastructure by beautification project of workplace (5s)

According to the international standard organization [10], each organization must provide the necessary infrastructure such as building, workplace, equipment & supporting devices. This project was carried out to develop the communication, employees' participation and create a happy environment.

This design named as 5s, suggest 5 principals for achieving better quality in workplace: separating necessary items from unnecessary ones, Sorting out, Systematize ,Shining ,Standardize and Self- Dicipline [11].

The ultimate goal of 5s is preventing the waste. In the third phase of this project that is Shining, the reviewing of the equipment was done. Defects are detected in machines with the cleaning of equipment, computers, heating, cooling appliances and visual management. Matching parts & bolts, lack of dust and bits of paper in computers, printers, controlling the undamaged cables were carried out in the third phase.

If users are familiar with the mechanism of devices, opening & closing components, reviewing will be done better.

For effectiveness of TPM, Shamsnejad, et al. (2008) [1]recommended that vendors should be obliged to provide the Persian translated brochures and simple mechanism for users and clarified the possible failure of the device, possible reasons of occurrence and eliminating errors in a clear & simple way. Users have some responsibilities including:

- cleaning the device before & after using
- utilizing controls to evaluate the performance of the device
- drawing standard diagrams and performance samples during a specific period of time and reviewing them.

Shamsnejad, et al. (2008)[ibid] have suggested the training of repairs to the users (needless simple repairs), holding training courses for employees out of the workplace and providing practical solutions in the installation of devices. Handling some responsibilities of TPM to the users like cleaning with the third phase and installation of devices like beautification with the fourth phase and getting staff's attention in both systems that cooperate with each other. Thus, the way of doing the task was documented for preparing the classified instructions.

2.2.4 Recording , collecting & Processing data

To design and perform TPM processes, it was necessary to provide maintenance processes, record worksheet and gather useful information.

In documentation process, the purpose of process, scope, methodology, monitoring indicators, responsibilities and authorities of each person were recorded. For example, it is shown in the process of monitoring the cooling, heating, telecommunicating, lighting and computer system that the expert not only focuses on reviewing & cleaning the device, but also informs the relevant officials about any defects by filling the worksheet No.1 out to predict the major damages.

Worksheet No.1 Problem identification & Request for defect removal in computer

From: ....

To:Expert Information & Communication Technology 

Title: bugs in computer

Since this computer system has some problems as mentioned below, please take appropriate action to resolve the defects.

First & Last Name unit responsible Signature Date / /

No	Problem Description	Actions	Date

The above sentences are approved by Expert Information & Communication Technology

Signature:

In addition to outlining the work procedure and documentation process , it is very important to be careful in preparing checklist with key components. In this worksheet , the name of the device, specifications, property number, date of visit, user's name, the name of key components , the safety of the device, time intervals and rework were recorded.

Checklist as a simple control device can be used to implement TPM. However , AliAsghar Nahalparvari (2009)[12] has utilized it to take care of the cars as a proper method for protecting devices.

In his research entitled " protecting machinery through oil analysis " in road transportation office in East Azerbaijan, he noticed the increase of used oil function and prediction of repairs before great damages through the record of metal erosion by the influence of contaminants, especially water and inappropriate oil in machinery. So, he recommends machinery maintenance as an effective method for production and repairs.
Protection is often done with a checklist. By considering this objective, not only the work procedure was developed , but also simple & complete control checklists were prepared to show the status of devices & equipment well. It is possible to gather data easily by these checklists.

Table 1 - Check list of monthly monitoring of computer systems

No	Unit Name	user name	MB	CPU	RAM	HDD	CDD	CD R/W	VGA	LAN	SOUND	service	PRINTER	label printer	monitor	PRINTER	CASE	battery	status of the FAN

With the implementation of 5s, maintenance activities and sending a report about the deficiency of the device were done by users.
Furthermore , automatic control, the process of collecting data, reviewing heating, cooling, telecommunicating and lighting were carried out by the staff who was familiar with the facilities affairs. An IT expert was in charge of monitoring computer systems.
Time selection for reviewing & handling the device required an expert. For example, in educational organization for checking computer systems, in addition to two-month control (controlling the internal network from transferring virus) and two periods of time, before & after, the issuing of the notification are recommended. A preventive maintenance was used for the other systems. For instance, to handle heating, cooling and facilities systems, two periods of time , beginning and ending of each season (the second of May & the second week of October) were considered. Damages and waste of resources & equipment were identified.
Computer systems were monitored every 2 months, but the other devices like cooling, heating, telecommunicating, lighting & sound, every 3 months. A report was prepared according to the safety condition of the device.
Although all staff have responsibilities in TPM, some of them are in charge of more particular authorities. For example, experts of agencies were responsible for monitoring & reporting about the deficiencies regularly. Facilities and technology staff were obliged to monitor the device within 1 week and reported the defects by completing Table 2. Monitoring staff did the replacement of worn parts, lubrication and joints control. The task of preparing and providing the necessary parts was on a burden of service& supplying expert.

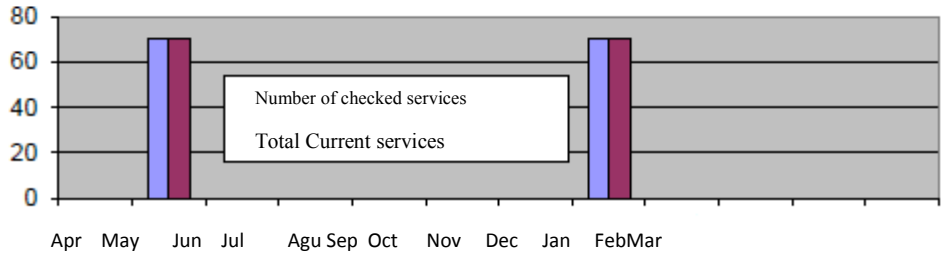
Table 2. Reporting about the equipment failure in zone 2, Educational Organization

Device Name:	**Property Code:**	**Installation Location:**				
Room No.	**Type of Damage**	**Declaration Date**	**Long Pause**	**Effective Date**	**Failure Description**	**Replacement Parts**
Responsible for Monitoring:		Responsible for Following :				

2.2.5 Calculating indicators and monitoring the continuity of the maintenance system

For fulfilment of programs, planned objectives and ideal criteria, controlling the number of checked devices in due time in relation to the total referred request, was considered as the indicator in TPM.

Process Name: Cooling & Heating System	Monitoring Period: Yearly	Code: 2302/20/17 K
Monitoring Date:	Limitation:	Monitoring Criteria: number of services done



Analysis:
Corrective Action (if needed):
Expert Signature, Deputy Signature, Manager Signature

Figure 1. Monitoring Report

Experts in services and technology were required to draw bar charts based on records in the worksheet requests and removing the defects. Also, they should record their analysis from the current status.

The task of auditing team was to monitor the right performance and evaluate the graph. A team of 5 trained experts by the help of planning deputy were responsible for auditing the process after passing the auditing courses. All colleagues would be informed through the auditing programs. Each unit was audited by previous notice. Since the goal of auditing is reforming not surprising. Auditing process was the introduction of inspector, identifying the limits of authorities and evaluating procedures. According to the results of monitoring, technical evaluation , completed worksheets and checklists , it was necessary to show that there was no gap between the acceptable level and results, or the gap has been resolved by a corrective action [13].

TPM management system was reviewed by the head after auditing. In periodic review (every three months), operational programs & monitoring graphs were evaluated by the president and his deputies. In order to eliminate the gap between the current status & acceptable level, regional managers had face – to – face discussion with experts, introduced suitable resources and performed reforming actions. The expert should solve the problem in a specific time.

2.2.6 Elimination of the failure with reforming or preventive actions

As it was said earlier, it is possible to take advantage of predictive maintenance after the implementation of a preventive maintenance for some period of time. Completed checklists and statistical data will help managers & experts in designing programs and periodic maintenance. It means that the working team was able to identify which season each computer needs virus & service checking during a year. For example, this demand will be more in August and before issuing the sentences and notification and after or which factors cause the problems, then it was resolved. For instance, some of the destructive and malfunctioning factors were: power fluctuations, lack of power in fuses, worn & long cables. For electronic equipment security, power electronic system of the organization was reconstructed and reformed by consulting with an energy consultancy company. Some of the corrective actions done in a period of time including shortening cable route, using low consumption light bulbs & repairing fuses. It is obvious that for increasing the predictive power of events, possible failure and preventive actions, TPM will be implemented in more courses and longer period of time. By the continuous implementation of TPM, increasing productivity and continual improvement in organization will be achieved.

3. RESULTS

TPM management system aims to create the best & the most healthy organizational environment. Staff ability and their professional knowledge were improved by the implementation of this system in zone 2, Shiraz educational organization and 40 hours of training. Some of the system achievement were: increasing morale, decreasing work pressure, enhancing comfort and increasing service quality. Workplace adornment, not only created a good opportunity for better TPM implementation but also caused happiness, beauty, empathy and cooperation for the educational system. Continuous reviewing & monitoring of senior managers would help the organization for better organizational communication & information exchange in different levels of organization.

Besides reducing the sources consumption through preventing damages to services & machines and improving energy management system , it could save 35% of expenses & energy fuel in 1387 in comparison with last year , also zone 2 had 92.3 % annual energy saving in 1388 [9].

Finally, TPM increased the productivity & customer satisfaction by attempting to eliminate & decrease six mentioned damages and major loss in equipment efficiency. So that, the customer satisfaction increased from 40% to 70% from October to April based on worksheets of customer viewpoint.

In TPM, customer satisfaction & productivity will be enhanced just by the application of a few simple control devices.

4.Conclusion

Organizations are obliged to utilize new innovation in customer services due to the rapid change growth & global competition. Each organization strives to achieve its goals, perform its mission by taking advantage of technology & modern equipment, increase their fitness in interactions and environmental changes, replace restrictions with opportunities and provide a pleasant environment for customers. It is recommended to use TPM for achieving the productivity, decreasing expenses, increasing the effectiveness of equipment which are manager concerns.

Some of the TPM applications are: increasing productivity, decreasing expenses, providing timely customer service, creating security at workplace and enhancing morale. Those organizations which want to be recognized as successful organizations must be supported by efficient and effective repairs & maintenance. In this paper, TPM was considered as an essential & effective factor in increasing productivity of equipment & machines and providing appropriate services. Crucial factors in a successful TPM was introduced as leadership commitment and support, staff participation, drawing devices & checklists and continuous working.

A periodic & step by step project for those who want optimal performance at global level was summarized briefly.

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