

A MODEL FOR PREVENTIVE MAINTENANCE SCHEDULING – A STEP TO IMPLEMENT TPM IN ORGANIZATIONS

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ABSTRACT

Maintenance is essential for machines or equipments. Without maintenance machine or equipment cannot work properly throughout its service life. To perform maintenance activities, the organization needs to ensure maintenance scheduling in time. Case study shows that, in Bangladesh most of the organizations are practicing preventive maintenance even some are still practicing only breakdown maintenance. Among them most of the organizations perform the maintenance scheduling manually which is time consuming and which is also troublesome for record keeping. In order to overcome those problems, this research proposes a model for preventive maintenance scheduling. Application database software using C# and MySQL is developed supporting the proposed model. This software may be treated as a helping tool to establish TPM partially in organization by sharing information for autonomous maintenance program and a scheduled/periodic maintenance program.

Keywords: Preventive Maintenance, Automatic Scheduling, Information Sharing.

1. INTRODUCTION

Maintenance management plays a vital role in manufacturing or even in service industries. Commercial organizations strive to make a reasonable profit; public and non-profit organizations strive to operate in a cost-effective manner. Either way, the businesses must deliver products or services at optimum cost and on schedule in order to be judged effectively [1]. To achieve these goals, organizations use enormous mechanical, electrical, structural equipment, which need maintenance activity for their proper functioning. Almost every organization has a maintenance department for the maintenance of the equipments or machines.

There are different ways used to manage the maintenance activities. An important one is preventive maintenance (PM) which is a schedule of planned maintenance actions aimed at the prevention of breakdowns and failures. It is the maintenance carried out at predetermined intervals, or other prescribed criteria, and intended to reduce likelihood of an item not meeting an acceptable condition [2]. The primary goal of preventive maintenance is to prevent the failure of equipment and machine before it actually occurs. The ideal preventive maintenance program would prevent all equipment failure before it occurs. In most organization, this type of maintenance scheduling activity is paper based as well as manual. We also found that the histories of maintenance are not kept in an organized way in most of organizations. Some of them keep the maintenance history according to machine / equipment, some according to date. Though some organizations use ERP

software for maintenance scheduling, but they are still much more expensive and cost ineffective for most of the industries of Bangladesh. Moreover, most of the ERP software is client server based [3], which needs internet connection but in Bangladesh still now internet connection with proper data transfer rate is not available everywhere. In this paper we propose a model for preventive maintenance scheduling which can help to maintenance in an effective manner. We also develop application database software, which can help to automate periodic scheduling. The commercial software C# and MySQL [4] is used in creating the database. In order to select the features provided in the software, some field data are collected from different organizations. The developed software for preventive maintenance scheduling eliminates paper work and cost and makes the periodic scheduling more accurate. It also includes maintenance history, spare parts inventory control and list of break down maintenance. From the maintenance history, one can analyze the previous data and can change the periodic schedule and take necessary steps.

The proposed model and database software will also decrease cost of replacement, system downtime and better spares inventory management. It is shown that the developed model and database support some goals and pillars of TPM (Total Productive Maintenance) [5]. Thus it might help to implement TPM in an organization. two-line space between the keywords and the top of body of the text.

2. PRESENT SITUATION OF MAINTENANCE MANAGEMENT

A case study is performed in several manufacturing

and service industries in Bangladesh to collect information of maintenance management. The case study sort out the following points:

- There are three types of maintenance performed. They are preventive maintenance, breakdown maintenance and predictive maintenance. Preventive maintenance is considered as most important among three.
- Most of the organizations have separate persons engaged for scheduling the preventive maintenance. Most of them have manual scheduling process.
- The maintenance history is recorded manually.
- Most maintenance activities are done daily basis.
- The maintenance duration of each distinct machine or equipment is selected according to manual of machine/equipment and some times according to experience of experts.
- Operators are not trained properly in maintenance activities. Operators have little knowledge about the basic maintenance activities like lubrication, inspection, tightening etc.
- There is little cooperation between the operation and maintenance department. The operator's philosophy is "I operate, you fix".
- Operators are not responsible for cleaning and tidiness of the equipments area.
- The daily maintenance task sheet is prepared manually.

3. PROPOSED MODEL FOR PM SCHEDULING

From the analysis of data collected, we have found that an automatic maintenance scheduling can remove some drawbacks of maintenance management exits in the industries of Bangladesh. To satisfy those drawbacks, we proposed a model for preventive maintenance management as shown in figure-1.

The relation between the maintenance department and operation department is also defined. In our proposed model, maintenance department is the centre of control where a data base is kept. Maintenance department entries information to the database after a new machine or equipment is launched. The information might be collected from the following three sources.

- manual of machines/equipments
- maintenance history analysis
- experience of experts

The database keeps the records of inserted information and according to the inserted information, the software automatically prepare a maintenance schedule in daily basis. The input and output (automatic) of the database are shown in figure-3.

The maintenance department could retrieve the equipments which should be considered for maintenance for a specific date. A task sheet of those machines could be printed. According to the information in the task sheet, maintenance department would decide whether this task is done by the department itself or send it to the operations department for the basic maintenance activities. Once the maintenance for that day is finished, the feed back of the scheduled maintenance is updated in the database by the maintenance department. Database

automatically changes the maintenance schedule for the following days.

The maintenance history of a specific machine or equipment is also maintained in the database. Thus by sorting major breakdowns and reoccurring breakdowns from the maintenance history, the maintenance department can take corrective actions. Beside these activities, maintenance department also performs time based maintenance activity. The operation department mainly operates the plant, beside it in our proposed model operation department performs basic maintenance activities which are given in the task sheet. The maintenance department would train the people of operation department for these basic maintenance activities. Our proposed interaction of the maintenance department with the database is shown in figure-3.

We also propose the following activities of the maintenance department and operation department-

Maintenance department

Repairs & Engineering	Preventive maintenance
Safety	Planning and scheduling
Estimating	Stores control
Perform time based maintenance	Quality Assurance
Employee relations	Training (the people of operation dept.)
Record keeping and Data base management	Budgeting & financial planning
Reports and analysis	Construction and rescheduling

Operation department

Keep the operation smooth	Perform Basic Maintenance Activities such as: Cleaning, Lubrication, Adjust, Inspection
Receive and deliver work order to maintenance department.	Get training from maintenance department.
To achieve better safety, health and environment work with EHS department	Report abnormalities to the maintenance department.

4. APPLICATION DATA BASE SOFTWARE

In order to implement the proposed maintenance model, a huge class of software is needed for various developing stages. Much commercial software is available which should be purchased to implement the system. Of course some software should be developed to provide desired feature to the maintenance department. An important task is to create database software. A large class of database is a significant criterion for such a model. One thing should be kept in mind during the development of software is that software should be

flexible to use and be simple to suit the existing infrastructure in organization [6].

The steps given in figure-4 are followed to create a database supporting the proposed model described in the preceding section where the input and output of the data base are shown in figure-3.

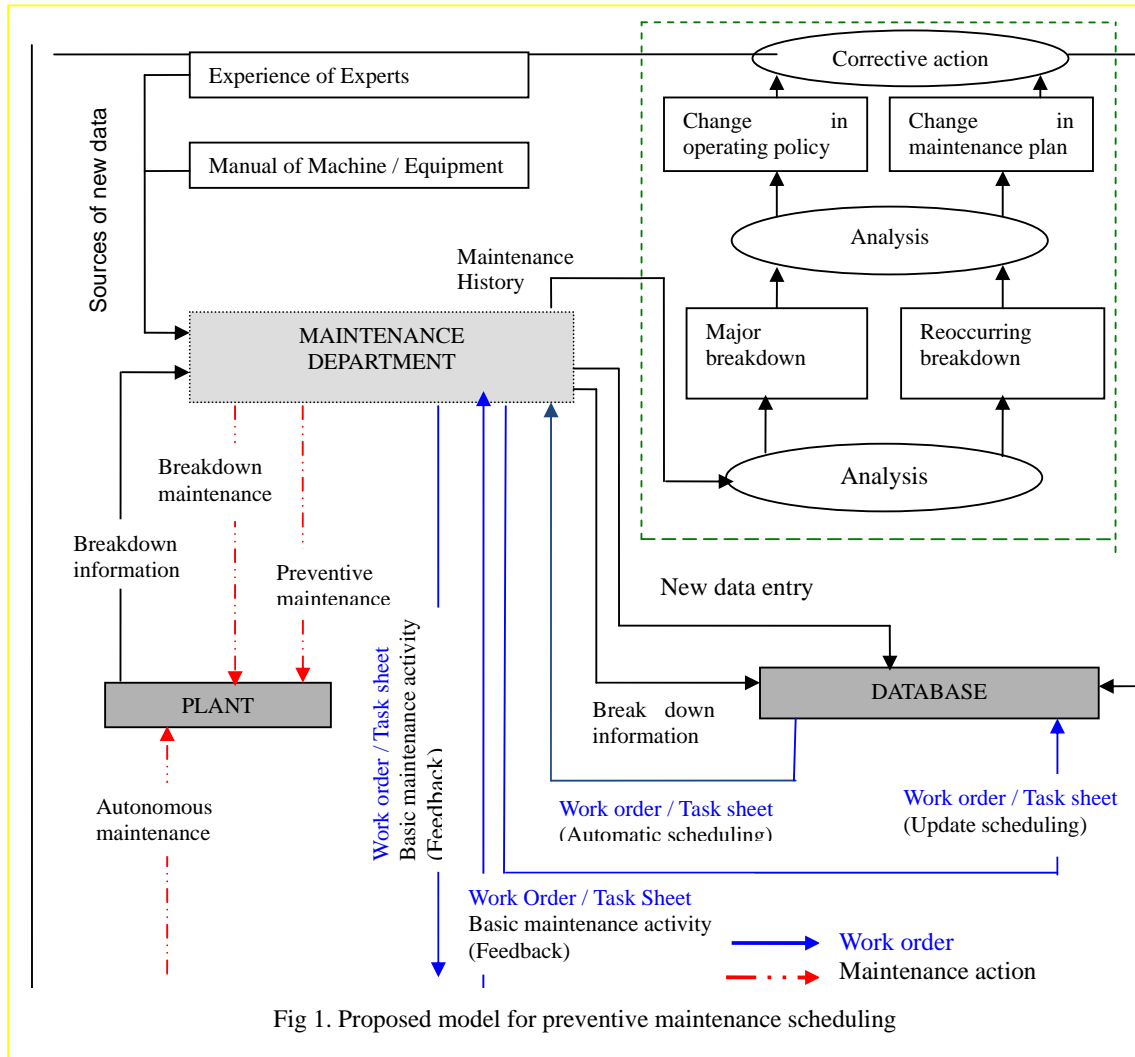


Fig 1. Proposed model for preventive maintenance scheduling

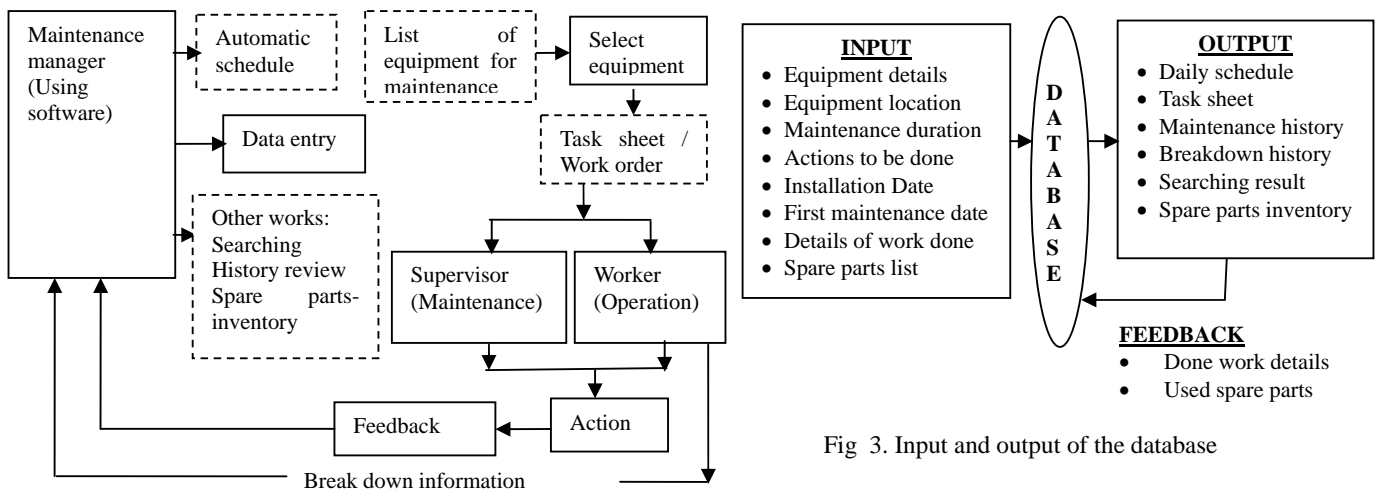


Fig 2. Interaction of maintenance manager with

Fig 3. Input and output of the database

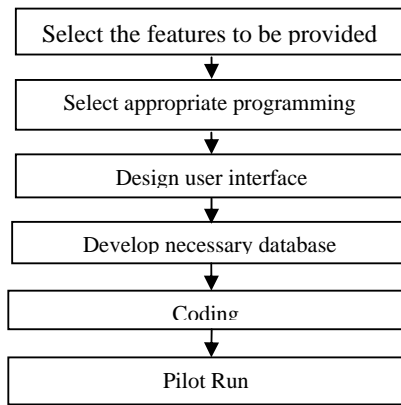


Fig. 4 Steps of developing software

The features provided in the database, are selected from the information collected from different industries with the help of some questionnaires. With its intuitive and user-friendly design the developed database integrates preventive maintenance work order, scheduled work orders, spare parts inventory control, maintenance history and equipment searching to benefit the maintenance manager.

Database schema is created using columns and rows in tables. We use My SQL database software [5]. Computer code was written in C# language using visual studio 2008.[6].

The first window of our created database are shown in figure-5. Some pictorial view of the features of the developed application database software is given below. It includes new data entry (figure-6), automatic scheduling for a specific date (figure-7), specification of a item (figure-8), a task sheet (figure-9) that will be given to the maintenance people for proper action. It also provides the searching options of any equipment or spare parts (figure-10 and figure-13). The database maintains the history of previous maintenance (figure -11 and figure-12) and spare parts inventory (figure-14). Huge number data could be kept in the developed database. The database manager should update the data base after the maintenance work every day through figure-8. It will automatically reschedule for the following days.

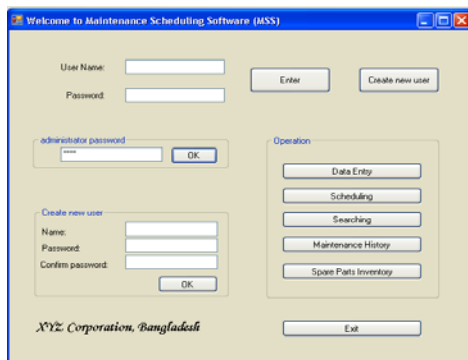


Fig 5. First window of the database software

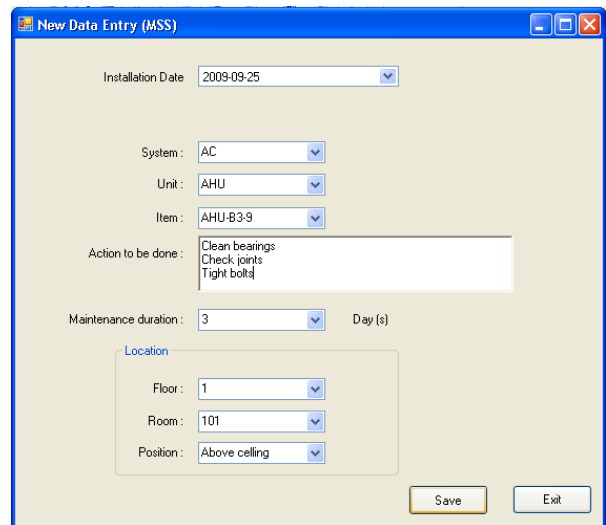


Fig 6. New data entry

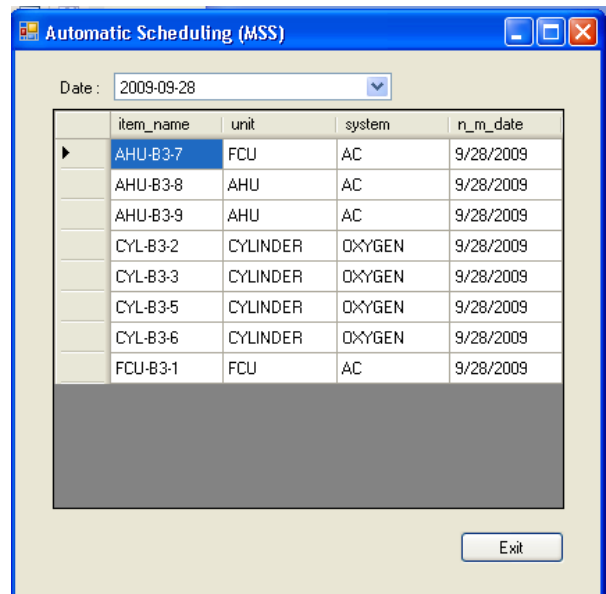


Fig 7. Automatic scheduling

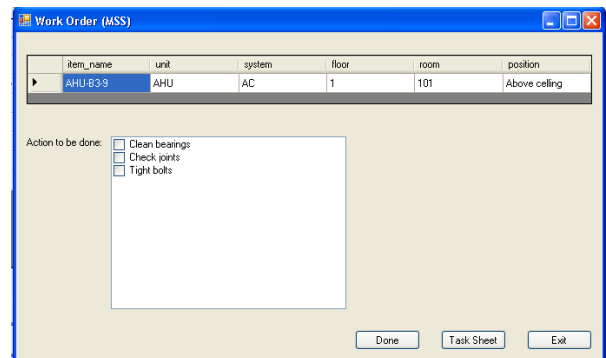


Fig 8. Work order

Fig 9. Task sheet

Fig 10. Searching

item_name	unit	system	done_date
AHU-B3-7	FCU	AC	9/28/2009
AHU-B3-8	AHU	AC	9/28/2009
AHU-B3-9	AHU	AC	9/28/2009
CYL-B3-2	CYLINDER	OXYGEN	9/28/2009
CYL-B3-3	CYLINDER	OXYGEN	9/28/2009
CYL-B3-5	CYLINDER	OXYGEN	9/28/2009
CYL-B3-6	CYLINDER	OXYGEN	9/28/2009
FCU-B3-1	FCU	AC	9/28/2009

Fig 11. Maintenance history

item_name	unit	system	done_date	action_done
AHU-B3-9	AHU	AC	9/28/2009	
AHU-B3-9	AHU	AC	10/1/2009	Clean bearings
AHU-B3-9	AHU	AC	10/4/2009	Clean bearings
AHU-B3-9	AHU	AC	10/7/2009	Check joints
AHU-B3-9	AHU	AC	10/10/2009	Clean bearings
AHU-B3-9	AHU	AC	10/13/2009	Check joints Tight bolts
AHU-B3-9	AHU	AC	10/16/2009	Clean bearings

Fig 12. Item history

sl_no	item_name	unit	system	ins_date
66	AHU-B3-9	AHU	AC	9/25/2009
67	AHU-B3-8	AHU	AC	9/25/2009
68	AHU-B3-7	FCU	AC	9/25/2009
69	CYL-B3-5	CYLINDER	OXYGEN	9/25/2009
70	CYL-B3-3	CYLINDER	OXYGEN	9/25/2009
71	FCU-B3-1	FCU	AC	9/25/2009
72	CYL-B3-6	CYLINDER	OXYGEN	9/25/2009
73	CYL-B3-2	CYLINDER	OXYGEN	9/25/2009
74	CYL-B3-8	CYLINDER	OXYGEN	9/28/2009
75	FCU-B3-6	FCU	AC	9/28/2009
76	AHU-B1-18	AHU	AC	9/28/2009
77	CYL-B3-23	CYLINDER	OXYGEN	9/29/2009
78	AHU-B1-14	AHU	AC	9/29/2009
79	AHU-B3-19	AHU	AC	9/29/2009
80	CYL-B3-9	CYLINDER	OXYGEN	9/29/2009

Fig 13. List of all items

system	item	no_of_item
Oxygen Cylinder	100 liter	23
Oxygen Cylinder	50 liter	23
Oxygen Cylinder	70 liter	43
Bearing	B-DC-10	123
Bearing	B-DS-10	17
Bearing	B-DS-12	14
Bolt	B0-4-13	62
Bolt	B0-4-15	19
Bolt	B0-5-12	56
Photocopy	Cartage	3

Fig 14. Spare parts inventory

5. RELATION WITH TPM

The proposed model and data base software agrees with some objectives and goals of TPM. Those are summarized in Table-1 and Table-2.

Table 1

S / L	TPM goals [5]	Relation with proposed model
1.	Elimination of the six big losses (down time, speed, and defect)	
2.	An autonomous maintenance program	Interaction of the maintenance department with operations department
3.	A scheduled maintenance program for the maintenance department	Automatic scheduling of preventive maintenance
4.	Increased skills of operations and maintenance personnel	The maintenance department will train the worker of operations department in regular basis
5.	An initial equipment management program	

Table 2

S/L	TPM pillars [7] [8]	Relation with proposed model
1.	Planned Maintenance	Proper maintenance scheduling
2.	Training & Education	
3.	Focused Improvement	
4.	Quality Maintenance	Analysis from the maintenance history helps in quality maintenance.
5.	5s (Sort, Systematic, Shine the workplace, Standardization, Self discipline)	.
6.	Office TPM	
7.	Safety Health & Environment	Trained operators
8.	JISHU HOZEN = Autonomous Maintenance	Basic maintenance activities of the operation department and correlation with maintenance department

6. CONCLUSION

A case study on the present situation of maintenance management in several industries in Bangladesh is performed. Based on the information from the case study, a model for preventive maintenance scheduling is proposed as well as database software is developed supporting the model. In the developed software we tried to automate preventive maintenance the scheduling. The developed software will generate the information of previous maintenance history that helps in decision making of predictive maintenance. We tried to introduce an easy and convenient model of maintenance scheduling with the help of a simple but effective maintenance scheduling software. So the outcome of this research will benefit first and foremost the maintenance manager of industries in Asian developing countries like Bangladesh.

7. REFERENCES

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