

## **A Model for Automatic Preventive Maintenance Scheduling and Application Database Software**

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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, Task sheet, 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.

## 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. If the maintenance department gets any breakdown information from the plant, they make the breakdown maintenance immediately and revise the maintenance schedule in the database for that specific machine/equipment. 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
  - Planning and scheduling and rescheduling
  - Stores control
  - Perform time based maintenance
  - Training (the people of operation dept.)
  - Record keeping and Data base management
  - Reports and analysis
  - Budgeting & financial planning
  - Quality Assurance & Safety
- **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 Database 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.

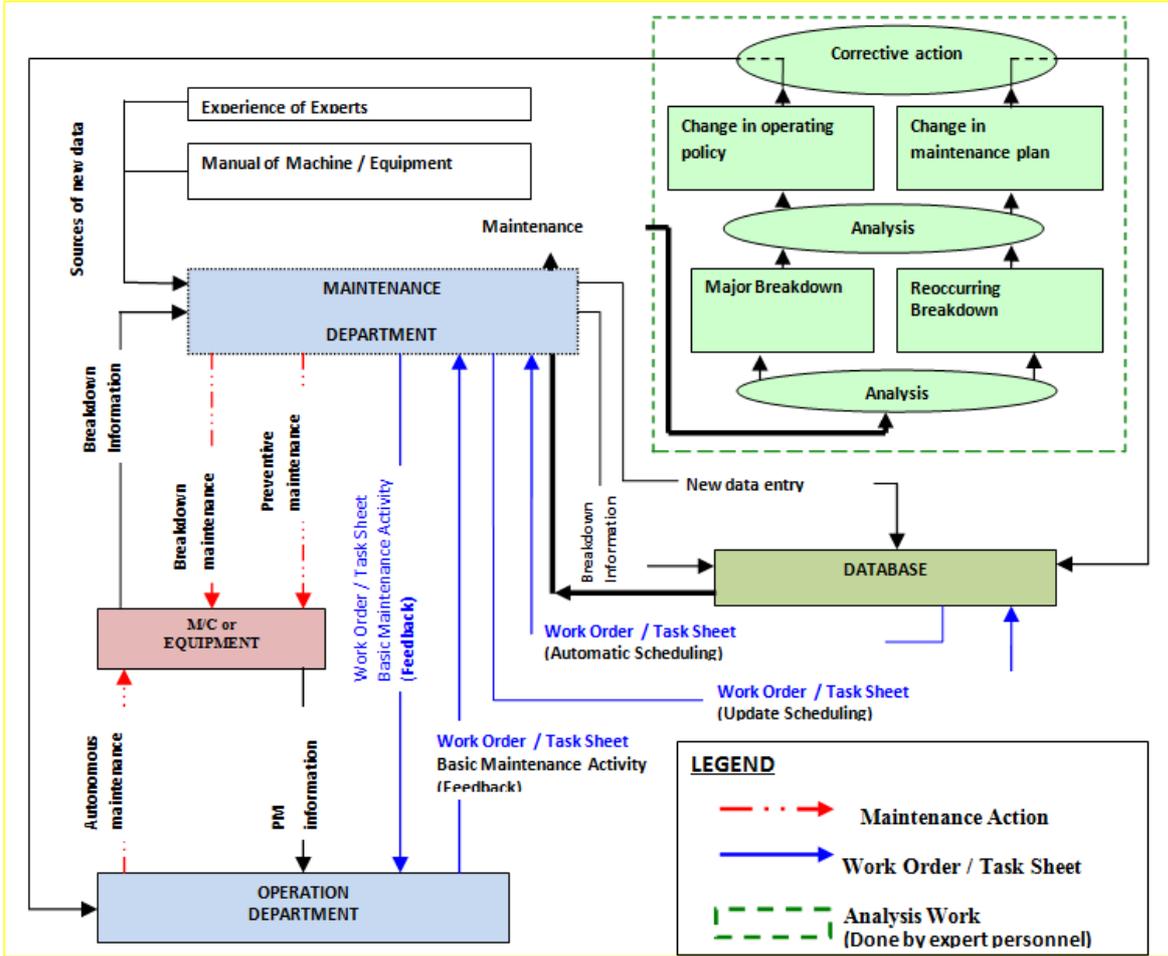
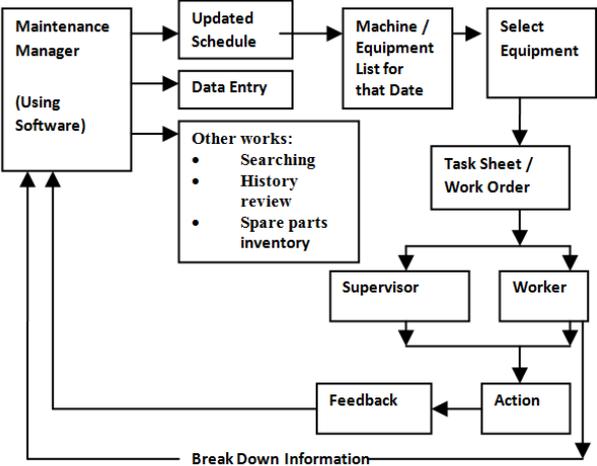


Figure 1: Proposed maintenance scheduling model



software interaction

Figure 2: Maintenance manager and scheduling

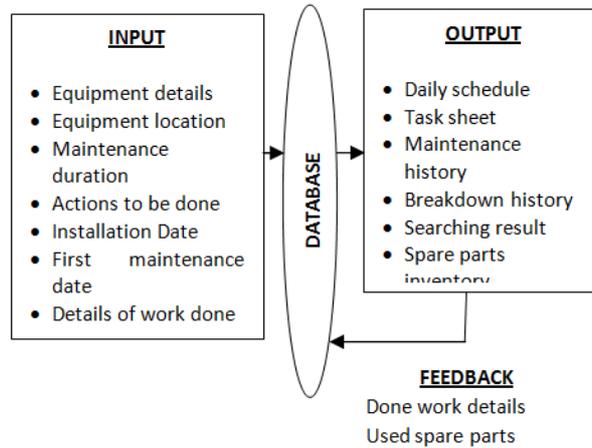


Figure 3: Input and output of the database

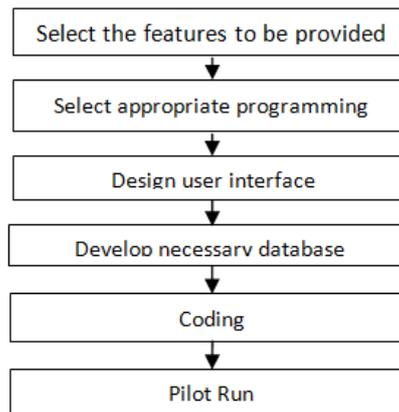


Figure 4: Steps of developing software

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 MySQL database software [5]. Computer code was written in C# language using visual studio 2008[6].

The first window of our created database is 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, specification of an item, a task sheet that will be given to the maintenance people for proper action. It also provides the searching options of any equipment or spare parts. The database maintains the history of previous maintenance (Figure 7) and spare parts inventory (Figure 8). Huge number data could be kept in the developed database. The database manager should update the data base after the maintenance work every day. It will automatically reschedule for the following days.

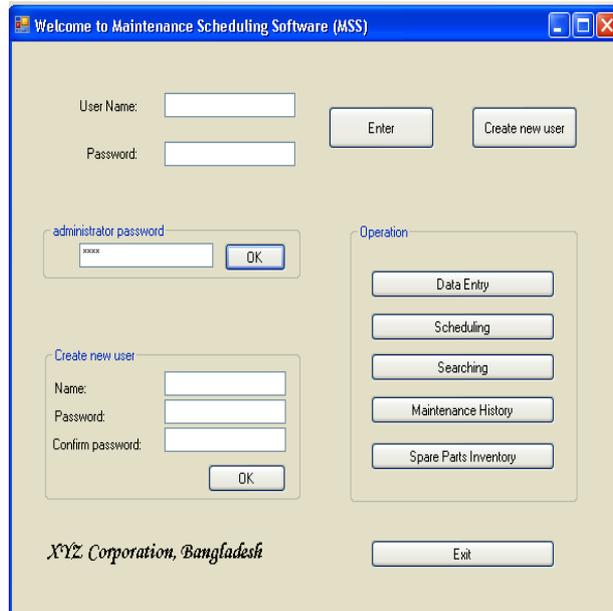


Figure 5: First window of the application database software

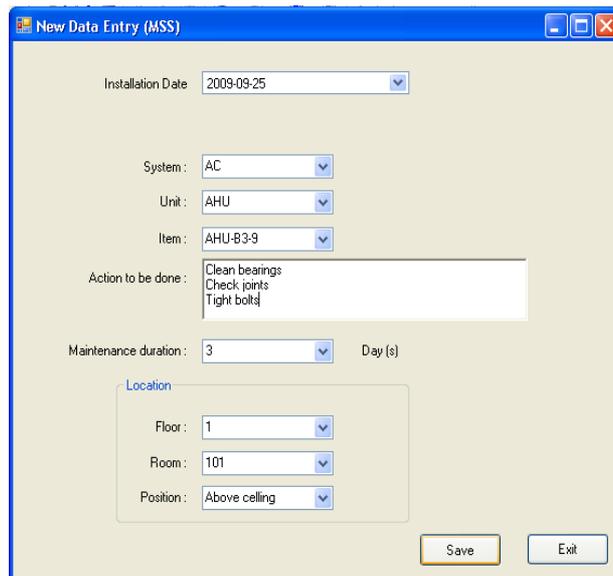


Figure 6: New data entry

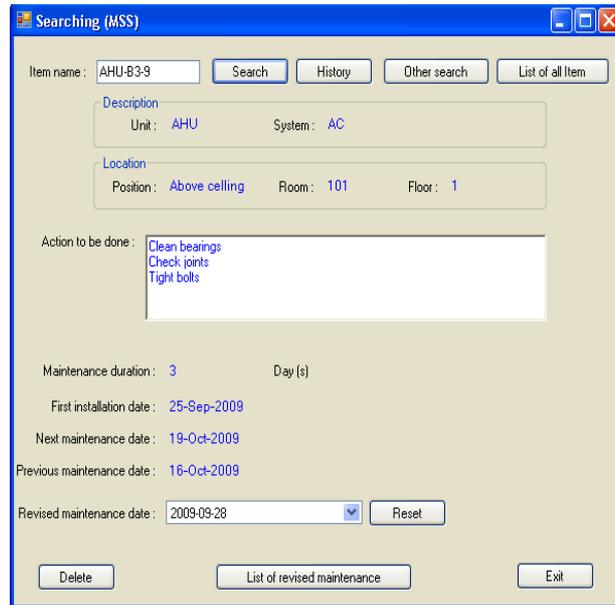


Figure 7: Searching

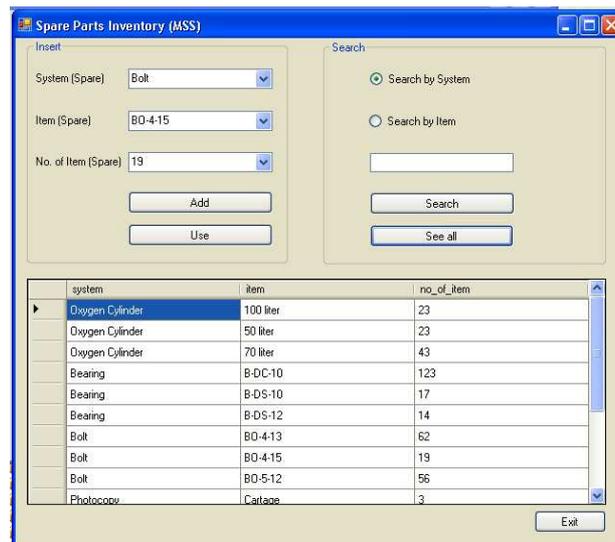


Figure 8: Spare parts inventory

## 5. Relation with TPM

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

## 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.

Table 1: Relations with TPM goals

S/L	TPM goals [5]	Relation with proposed model
1.	Elimination of the six big losses (down time, speed, and defect)	Though the developed software has not the facilities for recording the six big losses but it is recommended to further develop the software to make it possible to record and calculation of these losses and overall equipment effectiveness by it.
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	It is indirectly facilitated by the “spare parts inventory” part of the developed application database software.

Table 2: Relation with TPM pillars

S/L	TPM pillars [7] [8]	Relation with proposed model
1.	Planned Maintenance	Proper maintenance scheduling
2.	Training & Education	Training & Education of personnel is necessary for our proposed model. We strongly recommended it.
3.	Focused Improvement	To implement the model, Correlation among several departments should be strong enough, which is essential for continuous improvement.
4.	Quality Maintenance	Analysis from the maintenance history helps in quality maintenance.
5.	5s (Sort, Systematic, Shine the workplace, Standardization, Self discipline)	The proposed scheduling model is not directly involved in implementing 5s, but through tidiness, cleaning and sorting are facilitated by autonomous maintenance of operation department and the spare parts database of our software.
6.	Office TPM	Developed database software reduces paper works thus office TPM is also facilitated.
7.	Safety Health & Environment	Trained operators
8.	JISHU HOZEN = Autonomous Maintenance	Basic maintenance activities of the operation department and correlation with maintenance department

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