The Advantages of Using Computerized Maintenance Management System

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Abstract:

This proposal will state the Implementation and benefits of computerized maintenance management system. Some Equipment structures are too complicated that needs essential efforts in operation and design which eventually result in part break down. In any organization where manufacturing is the main scope, preventive maintenance plays a key role. Not only does equipment maintenance need to be intended for, the possibility and probability of breakdowns and disruption to operations must also be considered when planning and scheduling production. This paper examines the basis of various maintenance management strategies used to date in international manufacturing. These strategies help the maintenance function and allow the process of maintenance to be optimized. Particular attention is known as Computerized Maintenance Management Systems (CMMSs), the important issue is that how this particular strategy is successfully implemented in manufacturing company.

Key Words: Manufacturing; Maintenance Management; Computerized; Management Systems, Implementation; CMMS.

1 Introduction

1.1 Introduction of CMMS

This paper is to bring the attention to the considerable effects of computerized maintenance systems up on the overall production economies; the implementation of maintenance systems potentially leads to the reduction of production cost and raise of utilization of production capacities and improved production and a savings in maintenance time and cost. such result are rather hard to reach using even the most complicated production control and planning/scheduling algorithms developed with huge attempt. Co-ordination of production and maintenance plans by the use of computerized data base, including spare parts manufacture and inventory control, further contributes to the overall maintenance and production economies.

Computerized Maintenance Management Systems offer a way for companies to track equipment and inventory assets and accumulate all of the associated costs for labor, materials and tools. A computerized maintenance management system (CMMS) is a computer software program designed to assist in the planning, management, and administrative functions required for effective maintenance. CMMS is not just a means of controlling maintenance. It is now used as a means to ensure the high quality of both equipment condition and output.

1.2 CMMS features

1) Maintenance: work order management, scheduling, estimating, workflow, preventive maintenance, equipment hierarchies, equipment tracking, capital project management.

2) Inventory management: parts list, repairable item management, catalogs, warehouse management.

3) Procurement: purchase order processing, vendor agreements, contractor management & admin.

4) Human resources: health and safety, time control, skills management, payroll, benefits, recruitment, training
5) Financials: accounting, receivable, payable, fixes assets, budgeting.
6) Performance measurement and reporting
7) What-if scenarios, optimization, simulation features, condition based maintenance, condition monitoring.
8) Internet technology: relational database, paper-less transactions, paper-less reporting, performance monitoring, electronic queries, online and graphical instructions, e-procurement, software installation, Function time-sharing, global implementation, etc. (Eti, Ogaji, & Probert, 2006).

1.3 CMMS is the solution to these problems
The top five problems encountered by maintenance managers and suggest that CMMS is the solution to these problems. The problems are outlined as follows:

1) Little or no support from management to implement world class maintenance practices, CMMS reports can highlight the levels of downtime and reduce costs.
2) Inventory problems, the need to reduce spares and still have parts on hand. Control of spares modules is part of most of the modern CMMS packages.
3) The problems associated with maintenance personnel excelling at some jobs and lacking skills in other craft areas. CMMS allows managers to review this information, what work has been done and by who over a period and assign work appropriately in a variety of craft areas in the future.
4) Not enough maintenance personnel to handle the workload. CMMS can generate reports on labor requirements for each work order totaling the information by craft and week, showing imbalances and requirements for additional personnel.
5) Machines breakdown just before preventative maintenance is due CMMS can provide reports for each item of equipment, which can help pinpoint problem parts or requirements to reduce the preventative maintenance interval (O’Donoghue & Prendergast, 2004).

2 STEP-BY-STEP PROCESS FOR IMPLEMENTING A CMMS PROJECT

2.1 Form a team
1) Establish a team: The first step in establishing a team is to select the team members the team should consist of the plant engineer, maintenance manager, maintenance employees, and representatives from IT, operations, purchasing, and accounting departments, marketing, sales, and human resources.
2) External resources: Considering outside consulting company to guide and help you to implement the CMMS package in your organization because they can bring years of experience in order to help you.
3) Project leader needs to the project leader who knows as much about the hardware and system, the company structure, understand maintenance functionalities, and should be able to work with other departments.

2.2 Management commitment
Upper-level management must be totally committed to the CMMS project. This commitment must include allocation of manpower and resources needed to complete the project successfully.

2.3 Prepare for change
People do not change the way they work unless they understand the need for change and benefits to them in making the change. It is important they feel they are a part of setting the direction for change. You will be successful in bringing about changes to maintenance processes by involving key maintenance personnel in developing the new procedures.
2.4 Order software/hardware
During the justification process, you justified a CMMS and any hardware needed to support the project. Hardware includes PCs, servers, handheld devices, bar code and radio frequency identification device (RFID) readers, and accessories.

2.5 Define scope of project
You first review the existing workflow in detail and decide what changes you would like to make to improve productivity. Next, you need to determine which CMMS modules to implement.

2.6 Planning
Properly planning the CMMS implementation project is one of the key elements. In the planning phase you determine the “what,” “why,” “who,” and “how.”

1) Equipment data
2) Preventive maintenance
3) Procedures. Procedures can be preventive maintenance, safety instructions, or any other set of instructions. Each piece of equipment should have identified for it.
4) Labor. You need information on each maintenance technician such as name, address, phone, and social security.
5) Inventory (Mather, 2002).

2.7 Training
1) Basic training. Make sure people who will operate the CMMS are familiar with computer basics and operating system. If not, provide them with basic training so they are ready for CMMS application.
2) Application (CMMS) training. CMMS application training can also be done in two different phases, initial training to get the system up and running, and advanced training after spending a period of time with CMMS.
3) Internal training. You also need to train CMMS users with internal processes. This is often ignored in most CMMS implementation projects.
4) General training guidelines. Be sure that every trainee is given enough help to become comfortable and confident in what he or she is doing. Even a small shortage of needed training can cause an employee to backslide, lose confidence, and eventually cause project failure (Cato & Mobley, 2001).

2.8 Installation and configuration
You must make sure that necessary hardware and software other than CMMS is in place. For example, you might need new hardware or need to upgrade memory on your existing hardware.

2.9 Data gathering
Before gathering any data, check if you already have data in electronic format. It may be possible to transfer this data electronically without retyping. Explore that possibility first.

2.10 Data entry
The next phase is data entry after data gathering is completed.

2.11 Follow up/monitoring
There are many different KPIs (Key Performance Indicators) available for evaluating maintenance performance. Among them are maintenance dollars per pound of product, maintenance cost per company employee, and equipment maintenance hours per production hour. All of these KPIs contribute to the general measures of maintenance effectiveness, but no one KPI can monitor everything. (Poór, Šimon, & Karková, 2016)
3 ADMINISTRATION AND TRAINING: KEYS TO CMMS IMPLEMENTATION SUCCESS

The computerized maintenance management system (CMMS) or enterprise asset management (EAM) system has become a common tool for maintenance. The deployment of software and hardware to support different areas in facilities and plants, especially with fewer personnel, is no longer the exception; it is the rule. The number of plants and facilities with CMMS/EAM software has been increasing each year, but there are varying levels of reported results with each new system deployed. This is of concern because new computerized systems often replace old systems that were perceived as not living up to their advertisements. It was once thought that programming errors, hardware/software mismatches, and other similar problems could take the blame for implementations with only temporary or limited successes. There are many important factors leading to successful implementation. Administration and training are two areas that often do not garner commitment of necessary resources for the on-going upkeep of the maintenance system. In other words, proper training and administration are the preventive maintenance for the CMMS/EAM system.

3.1 System administration

Maintenance system training typically includes all system functionality for a select group of users, and then functional training in certain areas or modules related to an individual’s responsibilities. It also must include administration of the system and be:

1) Coordinated with need and function
2) Specific to function and include why change is necessary and where it must come from
3) Coordinated with implementation
4) Coordinated with immediate usage

Having a successful administrative system involves understanding the life cycle of the work order (and other process flows that contact the CMMS/EAM), and having a general idea of the work that takes place in the facility. There is an inherent conflict between the level of detail and the level of complexity required in administrative systems (procedures, forms, work orders, etc.). Obtaining the proper mix is required for good administrative systems. Additionally, it is necessary to accommodate purchasing, invoicing, and other internal functions through the CMMS or application program interfaces (APIs). This activity is designed to create more online collaboration and decrease the number of islands of information which maintenance has often been accused of harboring.

3.2 Begin with the end in mind

The end should be a time of continuous improvement based on numerous factors including maintenance information. Maintenance information should be derived from analysis of preventive and no preventive maintenance work order events, labor, and materials histories, and transactions created in conjunction with them. This will include a vast array of information including the cost of maintenance per machine in terms of downtime, incidents, and causes of repairs that are emergency or nonemergency, labor and material, etc. On the surface, this is an attempt to begin to actually utilize the CMMS to identify areas for change, and possibly quantify the value of this change. It is also to continue to achieve greater knowledge of where the maintenance dollar is actually going, in terms of both labor and materials.

3.3 The roadmap to a good startup

Before looking at the end result, take a brief look at what it takes to get there. An assessment and analysis should initiate the justification process, and help to define the functionality and sizing requirements for the system. Additionally, it should identify prime manual and/or automated processes that can receive change now, before the system is even selected. Modifications prior to system selection will lessen the chance of selecting a system that emulates an undesirable process currently in use. Computerizing a chaotic process will increase the problem geometrically or worse. Any justification necessary should be completed here as
well. This will provide direction and priority for implementation, since it will be imperative that the justification items be addressed to recover the investment in a timely manner.

System selection should result in choosing an existing product and version that has been on the market for some time, unless the company's size and special needs allow custom authoring or purchasing a system with source code to be modified. Once selected and purchased, the system must be installed. This includes necessary hardware and software, and typically is followed closely by training employees in critical areas initially and then periodically to support the implementation in multiple areas as needed. Then comes the arduous task of data installation—the physical inventory of plant machinery, preventive maintenance development, an inventory of parts, and the development of the necessary codes to support the required fields and those that will be used in analysis.

Although data installation is one of the areas that takes the longest, and is often stalled due to the large amount of resources expended to get this far, it is imperative that this be completed to get to the next step. The old adage "garbage in, garbage out" still applies. This does not mean it will be necessary to identify every piece of machinery down to the last armature and bolt. But by the same token, a furnace, packaging line, tank farm, or paint shop is too broad a description. It is necessary to find a middle ground that supports the implementation and functional capabilities of the system. Remember, there will be some level in the equipment hierarchy where most (if not all) work orders will be generated.

The problem now is how to get from having initial data in the system to having actual results data available that is reliable, and extracting results data out of the system. This is accomplished with good training and deployment of good administration systems. Training helps to insure personnel understand the systems in place and can use them consistently, including the administration systems.

### 3.4 Training

Training of personnel cannot be overemphasized, but can easily be overdone. More often, it is less effective than it should be. During CMMS implementation, training is often concentrated on the software and covers far too much for far too many. The area’s most often overlooked are in system administration. The original assessment and analysis should cover workflow analysis. The path of a work order should now be known, as well as other workflows in contact with the CMMS/EAM. Training must be completed for all personnel along the path and cover the skills required as well as explain the need for change. This helps to incorporate education into the training.

Training on handling the work order from start to finish should be done for all involved, including the originator. It is especially important to educate. Bad historical data can be found easily. Take a walk around the plant and look at repair work order problem descriptions. Descriptions of "down" or "doesn't work" etc., will typically be followed by a repair description of "done" or "fixed," etc.-not very useful for analysis. Train the originator to indicate what he observed and why he called. Numerous other opportunities for improvement exist in training methods.

1) Training must be coordinated with need and function.

2) Do not train everyone on everything. Only a limited number of personnel require OEM-like knowledge.

3) Training should be specific to function and include why change is necessary and where it must come from.

4) Do not train too early; coordinate with implementation. Trainees should leave class and use what they have learned immediately.

5) Train as close to the beginning of the turn as possible.

6) Try for short sessions that end early in the turn.
Training and administration provide the foundation for an installed system to become an operating system on a daily basis that contains good quantity and quality of data, representative of plant operations that can be used for analysis. When executed well, both areas will be considered at the beginning of installation, and through every upgrade, expansion, and change in overall business operations. The better the planning initially and along the way, the greater chance the CMMS will have of continuous usage and delivering long-term and continuous improvement, through the information it provides.

3.5 The relation between tool and successfully implementing a CMMS
If a CMMS is poorly selected, designed, and implemented, then the CMMS will fail to meet organizational requirements. The CMMS itself may have little to do with the failure. It is well established that application software may contain defects. These defects can compound the challenges associated with implementation. Even if the CMMS is perfect, the organization will encounter difficulty if the system is poorly selected, designed, or implemented. Solutions to organizational problems are seldom relieved through technology. It is the appropriate use of technology within a given business context that provides solutions. Some might argue that buying the newest technology helps (Autin, 2005).

3.6 The benefits of CMMS
1) The reduction of production cost.
2) Rise of utilization of production capacities and improved production.
3) A savings in maintenance time.
4) Increased labor productivity (Reduction of overtime, Reduction of outside contract work).
5) Increased equipment availability.
6) Longer useful life of equipment.
7) Inventory control (Reduced inventory costs)
8) Environment control (Safety issues, Compliance issues) (O’Donoghue & Prendergast, 2004)
9) Improve Maintenance Productivity
10) Improve Machine Quality
11) Reduce Down Time
12) Provide Better Service to Other Departments

4 MANUFACTURING MAINTENANCE OBJECTIVES
Considerable sums of money are wasted in business annually, because of ineffective or poorly organized maintenance. However, maintenance is only one element, which contributes to effective operation during the life cycle of an item of equipment. Maintenance has a very important part to play, but must be coordinated with other disciplines such as training personnel in appropriate skills, maintaining motivation and effective people management. Taken together, this approach—aimed at achieving economic life-cycle cost for an item—has been called ‘terotechnology’, and defined by Wild as “the multidisciplinary approach to the specification, design, installation, commissioning, use and disposal of facilities, equipment and buildings, in pursuit of economic life-cycle costs”. The formal definition of ‘terotechnology’ according to the British Standard, BS 3811:1984 is “a combination of management, financial, engineering, building and other practices applied to the physical assets in pursuit of economic life cycle costs”. Williams, Davies and Drake go on to clarify this definition by stating that “‘terotechnology’ is concerned with the specification and design for reliability and maintainability of plant, machinery, equipment, buildings and structures, with their installation, commissioning, operation, maintenance, modification and replacement, and with
feedback of information on design, performance and costs”. Hodges simplifies these definitions by explaining ‘terotechnology’ as “the achievement of the best value for money using techniques which are many and various in their forms, approach and application”. Life cycle costing (LCC) involves collecting all the cost information incurred during equipment life.

TABLE 1. SUCCESS FACTORS FOR CMMS IMPLEMENTATION

<table>
<thead>
<tr>
<th>What do you consider are the two most important aspects of your implementation that led to your success?</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factor</td>
<td>Most Important</td>
</tr>
<tr>
<td>Senior management commitment</td>
<td>15</td>
</tr>
<tr>
<td>Effective training</td>
<td>12</td>
</tr>
<tr>
<td>Choosing the right CMMS</td>
<td>10</td>
</tr>
<tr>
<td>Effective change management</td>
<td>10</td>
</tr>
<tr>
<td>Focus on business benefits</td>
<td>5</td>
</tr>
<tr>
<td>Adequate budget</td>
<td>6</td>
</tr>
<tr>
<td>Effective EPR</td>
<td>5</td>
</tr>
<tr>
<td>Effective project management</td>
<td>5</td>
</tr>
<tr>
<td>CMMS Vendor support</td>
<td>7</td>
</tr>
<tr>
<td>Consultant support</td>
<td>4</td>
</tr>
</tbody>
</table>

Decisions made at an early stage in the design phase can have significant effects on the cost of running a particular machine throughout its life. There is evidence to show that the breakdown of lifecycle costs is as outlined in Table 1. The objective of maintenance is to try to maximize the performance of equipment by ensuring that, items of equipment function regularly and efficiently, by attempting to prevent breakdowns or failures, and by minimizing the losses incurred by breakdowns or failures. In fact, it is the objective of the maintenance function to maintain or increase the reliability of the operating system taken as a whole.

Good management of maintenance can reduce costs. Figure 1 shows the relation between management of maintenance and cost which indicates that increased effort in preventative maintenance has the potential to reduce the cost of repair. If it were possible to define both of these curves, then it would be a simple task to determine the minimum cost maintenance policy. However, it is not as clear-cut as this and therefore maintenance policy is much more difficult to formulate. The overall objective is to minimize the total cost of maintenance by minimizing one or both of the costs that contribute to it. Reducing the cost of preventative maintenance (PM) by minimizing the level of PM carried out in the manufacturing facility can increase downtime due to breakdowns and consequently necessitate the need for more repairs. On the other hand, increasing the level of PM to too high a level will introduce unnecessary extra maintenance cost without necessarily minimizing the risk of breakdown. The overall objective is to obtain an optimum level of preventative maintenance so as to reduce total maintenance cost. Achieving this optimum delivers other benefits such as increased morale, reduction in random breakdowns, improved quality of product, increased equipment availability, reduced delivery times and of course increases in profitability. The strategies utilized successfully in the area of maintenance management optimization include:

1) Reliability Centered Maintenance (RCM),
2) Profit Centered Maintenance (PCM),
3) Asset Management (AM),
4) Condition Based Maintenance (CBM),
5) Total Productive Maintenance (TPM),
6) World Class Manufacturing (WCM) through CMMS implementation.

These management philosophies essentially comprise of different techniques and tools with varying emphasis on individual factors, but achieve a very similar final objective, the optimization of maintenance. The goal is to obtain the maximum production output with the best organization and administration of maintenance management that Computer Maintenance Management Systems (CMMSs) have proved to be very beneficial (O’Donoghue & Prendergast, 2004).

![Fig.1 The relation between management of maintenance and cost](image)

5 CMMS INTEGRATION

5.1 CMMS Integration
CMMS software integration (or for that matter any software systems integration solutions) is the process of enabling two or more software systems to talk to each other by making common data available to each system and facilitating the exchange of this data between the systems. The data exchange can involve each system reading the other's data, writing to it or both. An obvious example is the integration of CMMS systems with a purchasing system. Most companies already have a purchasing system but almost all CMMS systems now come with their own. In all but the smallest companies the accounts and purchasing departments will already have their own financial, purchasing and inventory systems in place and they will not accept any move to the CMMS purchasing system. The maintenance department (via the CMMS/Maintenance Management Systems) may require that the availability of spare parts is checked before planned maintenance work orders are issued. To do this the CMMS software must be able to check the stock levels in the existing inventory software system. The systems integration solution in this case would mean making the spare parts database fields in the purchasing system readable by the CMMS software. It may also involve making the fields of the database writeable by the CMMS software in a situation where it is to be allowed to adjust spare parts inventory.

5.2 Problems with CMMS Systems Integration Solutions
Essentially, systems integration solutions require people with the required IT skills to make the links between the databases of the systems. This can only be done on open databases. These are databases within software applications that have been programmed to allow access from other applications that are suitable for integration and that permit the required data transfer.

When the system has been properly integrated it should work seamlessly with no errors but problems may arise in future if one of the software applications is upgraded or changed to a new version. The potential
for problems in this area clearly increases with the number of systems that are included in the CMMS system integration but the company making the change will generally assist by providing information for any modifications that become necessary as a result of the change (Gabbar, Yamashita, Suzuki, & Shimada, 2003).

5.3 ICT for integration
Web technology for the integration of the maintenance processes in a ICT project is to enhance maintenance process efficiency by bringing the expertise to the user via the Internet. The propose is to use of extensively powerful data structuring technologies, such as XML (Extensible Markup Language), application integration techniques and Internet-related technologies. To achieve the overall economic objective the proposal is to reduce the time for diagnosis and repair and prevent failures by condition monitoring the field equipment. The efficient implementation of a preventive maintenance management strategy involves three fundamental requirements. These are: the continuous assessment of equipment health, maintenance and repair operation process management and comprehensive data presentation and synthesis. A successful implementation of the functions mentioned above results in a fully integrated platform. The importance of the integration of data and industrial systems is to perform supervisory control or management or both. There are several technologies to choose from for the integration of data and systems. There are many advantages for the maintenance through the implementation of Internet and agent technologies. These advantages are due to the fact that the Internet is widely accepted among enterprises around the world and that the agent system provides the realization of intelligence and cooperative features for the automation systems used in industry. A platform is proposed so that it can support the agent technologies and information flow in e-maintenance. The aim of the platform is not only to support data or service integration but also to enhance knowledge management in an enterprise (through the integration of already existing knowledge bases and expert systems and the suggested agent systems). The multi-agent-based platform for e-maintenance supports the combination of technologies such as XML, Web services, and knowledge base systems. Web technology is used to integrate the systems within an enterprise and at the inter-enterprise level. The Internet technologies are flexible and have a great potential. But the only problem is to choose the right technology so that it can be utilized as efficiently as possible (Campos, 2009).

5.4 CMMS justification
Justifying the purchase of a computer-managed maintenance system can be extremely difficult. The barriers to expenditure approval often include lack of capital resources, prejudice against maintenance, and a failure to understand the system’s benefits. Many companies cannot afford to invest the money and manpower required to improve the effectiveness of their plants. The first, and probably most difficult, step in the justification process is a comprehensive evaluation of the maintenance organization. You must determine how well maintenance is performing today and then determine your objectives for improvement. One method of determining current performance is to evaluate reports from the cost-accounting and performance evaluation systems. Before you can develop justification for a new or upgraded CMMS, the important issue is to understand the specific functions that the system must perform to help you manage effectively.

5.5 Estimating the cost of implementation
It is extremely difficult to accurately estimate the costs associated with the implementation of CMMS. The actual effort required will depend on the current status of plant. If you have an established database that includes critical equipment/asset identification, equipment/asset histories, spare parts identification and tracking, and other such information, the effort should be much easier. There are much of the data in the computer required to build the CMMS databases. Some modification of the existing data format may be required when converting these data to the format required by the CMMS. It will be possible to estimate cost of implementation by using this source of databases (Cato & Mobley, 2001).

5.6 Identifying information technology requirements for maintenance management system
IT tools are important, and in many cases invaluable, when reaching the goals of maintenance. The factors of goals, expressed in terms of efficiency, effectiveness and cost-effectiveness, purpose and use should be
considered on organizational and individual level in order to identify the IT demands. Furthermore, investments in information technology without considering the actual conditions and maintenance strategy, as well as the IT maturity of the maintenance organization and its individuals, will most likely end up in underutilized IT systems due to, e.g., lack of functionality, lack of user knowledge or bad user interfaces. Correct level of IT applied, i.e. IT consisting of correct functionality required for planning, conducting and following up maintenance activities according to the maintenance strategy adapted, will contribute to successful maintenance management, which will have positive impact on enterprise competitiveness and profitability. Moreover, it is necessary to promote the use of a structured procedure for the identification of IT requirements for maintenance management. By applying a structured process, we can assure that the demands of IT support in the maintenance organization are met. Further work would be needed in the area of determining and identifying MMIT needs. Larger companies usually have resources to either customize commercial IT applications or to develop in-house solutions. Therefore, especially small and medium-sized enterprises would benefit from having easy to use tools and methods for determining their MMIT needs to be able to choose the relatively best solution available off the shelf (Kans, 2008).

6 CONCLUSION

Most organizations view maintenance as an expense and a cost center. A properly implemented CMMS can help maintenance cope with downsizing and turn maintenance into a profit center. It is important to bridge the communication gap between executive and maintenance management to increase overall productivity. The best idea is that the advantages of implementation of CMMS far outweigh its disadvantages provided that all situations related to costs should be considered and all steps to implement CMMS should be done one by one to reach to successfully process.

7 References: