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Radio Frequency Identification (RFID): A Technology for Enhancing Computerized Maintenance System (CMMS)

Arash Shahin
Associate Professor, Department of Management, University of Isfahan, Isfahan, Iran
Amir Mehdi Ghazifard
Master of Business Admionistration, Department of Manageement, Faculty of Virtual Learning, University of Isfahan, Isfahan, Iran

Abstract
While Computerized Maintenance Management System (CMMS) enables maintenance managers and supervisors to access information about equipment, manpower and maintenance policies, there is still a need to facilitate getting data/information into the backend database where it can be utilized by the organization as information to make decisions regarding the operation of the organization. Significant gains can be yielded through the use of the internet and the new connective technologies such as Radio Frequency Identification (RFID). The aim of this article is to demonstrate integration of the two subjects. For this purpose, CMMS and RFID have been introduced and their integration has been demonstrated and discussed. The findings imply that RFID can provide competitive advantages to organizations as a prerequisite and supportive technology for CMMS.

Keywords: CMMS, RFID, Integration, Technology.

1. Introduction
In the competitive world of manufacturing, the maintenance function requires the computerization of the data flow, which facilitates the collection, processing, and analysis of the data. Computerized Maintenance Management System (CMMS) has become popular in most organizations around the world. It is now a central component of many companies' maintenance departments, and it offers support on a variety of levels in the organizational hierarchy (Labib, 2004). CMMS enables maintenance managers and supervisors to access information about equipment, manpower and maintenance polices. This information

assists in improving maintenance effectiveness and control.

On the other hand, despite the complexity of the spare parts inventory problem, many inventory system management improvements can be achieved. Significant gains can be yielded through the use of the internet and the new connective technologies such as RFID (Radio Frequency Identification). Lead-time reduction, rigorous ordering and stock monitoring, wider access to suppliers from all over the world, better prices, eased communications with suppliers, improved access to updates and user guides are among the advantages provided by the internet and the new communication technologies.

The aim of this article is to demonstrate integration of CMMS and RFID. In the following, the two subjects are introduced and their integration is demonstrated and discussed.

2. Computerized Maintenance Management System (CMMS)

During the past 30 years, the term "CMMS" (Computerized Maintenance Management System) has become synonymous with productivity improvement and control of maintenance management processes (Mather, 2003). CMMS assists in managing a wide range of information on maintenance workforce, spare-parts inventories, repair schedules, and equipment histories. It may be used to plan and schedule work orders, expedite dispatch of breakdown calls, and manage the overall maintenance workload. CMMS can be deployed to automate the PM function and to assist in the control of maintenance inventories and the purchase of materials. CMMS has the potential to strengthen reporting and analysis capabilities. The capability of CMMS to manage maintenance information contributes to improved communication and decision-making capabilities within the maintenance function. Accessibility of information and communication links on CMMS ensures improved maintenance responsiveness, better communication of repair needs and work priorities, and improved coordination through closer working relationships between maintenance and production.

The application of CMMS indicates very mixed results. United States, the majority of companies has been using less than 50 percent of their CMMS capabilities. This means the data collected by these companies is highly suspect and probably highly inaccurate. One requirement for a company to be effective in CMMS usage is complete usage of its system and complete accuracy of the data collected.

The lack of complete usage of a CMMS is a critical factor in recordkeeping compliance. The lack of complete and/or accurate recordkeeping requires that companies maintain a separate regulatory recordkeeping system. In lieu of the separate system, many companies will fail a check of their documentation by a regulatory agency. It is only by dedicating sufficient resources to the CMMS utilization that companies will have sufficient electronic documentation for compliance recordkeeping. It should be noted that electronic data collection and reporting systems are acceptable to the regulatory agencies. This eliminates the need to have redundant paper systems in addition to electronic systems.

2.1. CMMS and the maintenance management pyramid

The maintenance management pyramid illustrates the structural relationship between functional best practice

disciplines for maintenance/asset management. As it is shown in Figure 1, CMMS is one of the major foundations and a prerequisite for developing such pyramid. Best practices are interpreted as the maintenance practices that enable a company to achieve a competitive advantage over its competitors in the maintenance process.

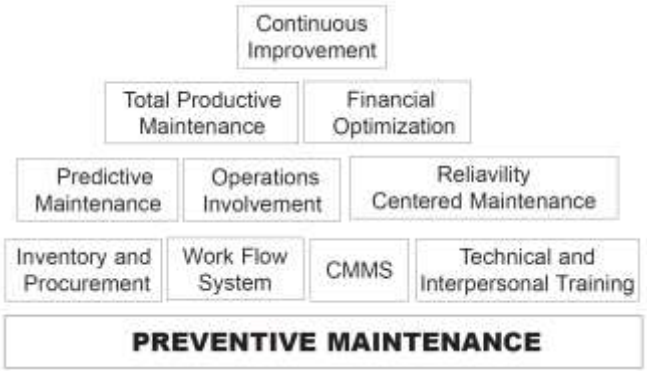

Figure 1. CMMS as a basis in maintenance management pyramid (Wireman, 2003)

3. Radio Frequency Identification (RFID)

The RFID technology has been drastically developed and improved for decades. Its capability to remotely store and retrieve item data can be utilized to replace the traditional approaches for item identification and data capture (e.g. manual entry or barcode mechanism). RFID technology is robust and has been used for some time in harsh manufacturing environments (Gould, 2000; Murray, 2003). Other applications include car toll tags and security-ID badges (Prater et al., 2005).

The key components of the RFID technology are the tag, reader and IT backbone (e.g. the EPC network). An RFID tag is a small object that can be attached to or incorporated into a product. Usually, an RFID tag stores a unique ID number and sends the stored ID via radio frequency. An RFID reader is a device that can receive the radio signal from the RFID tag. The IT backbone is used to gather the information from RFID readers and import the RFID information into the backend systems (Byfield, 1996; Hou and Huang, 2006). As an item with a RFID tag passes through a RFID reader, the tag sends the corresponding ID number to the reader. The reader then passes the ID number to a computer or backend application system via the IT backbone to figure out the identity with respect to the ID number. The RFID tags can be classified into two categories, namely passive tags and active tags (Howes et al., 1999). Passive RFID tags do not have their own power supply and the incoming radio-frequency scan (from a RFID reader) provides the power for the tag to send a response. On the other hand, an active tag has a power source and has a longer range and larger memory than the passive one. The unit price of an active tag is much higher than a passive one and, therefore, the passive tag is usually the candidate solution for supply chain applications in the real industry. The RFID technology can be used to detect item locations, distribution history of items, and item quantities in the supply chain and immediately transmit the logistics information to the backend systems for efficient decision support.

4. Integration of RFID and CMMS

The largest bottleneck that currently exists with any CMMS is the method or methods that are employed to get data/information into the backend database where it can be utilized by the organization as information to make decisions regarding the operation of the organization. Majority of the time data are entered manually by humans. This process is extremely labor intensive, prone to errors, and is costly for the company and clients of the company. Methods for automatically capturing field data to provide visibility into an organization's asset status and operations are limited and can be expensive. However, RFID technologies have recently emerged as the leading candidate to provide an effective, cost efficient solution to the data collection problem. To put the technology into context, RFID is one of many technologies which fall under the AIDC umbrella. AIDC, long used for identifying and tracking items, stands for automatic identification and data capture. This is a term that refers to any system that deploys a method of identifying objects, capturing information about them, and entering it directly into computer systems with little or no human intervention. Bar-code technologies also fall under this classification; however, RFID offers several key advantages over existing bar-code systems.

RFID middleware (management software). Middleware software, and specifically RFID middleware, is a very widely referenced term and is used in many contexts. However, generally speaking it refers to the RFID data management software that enables raw asset data to flow from the RFID tag to a software application (e.g., CMMS) or database. In some instances it is desirable to have data flow bidirectional (i.e., tag-to-database and database-to-tag). The main responsibilities of RFID middleware are to manage and monitor RFID data and devices (i.e., readers). RFID middleware encompasses the software that is present on the RFID readers and that facilitates the automated communication and data gathering from RFID tags as well as the transportation of the collected data into backend systems and software applications. Specific functions of RFID middleware include:

- Integration and support of read/write hardware devices (i.e., readers)
- Monitoring status of data and reader devices
- Management of RFID reader networks
- Maintaining security and integrity of RFID data
- Data event management (business rules and processes)
- Data filtering and cleansing

In addition, the software tools to develop RFID-based applications and integrate RFID systems are also classified under the RFID middleware umbrella. The diagram in Figure 2 provides a high-level illustration of how RFID middleware fits between a CMMS software application and the RFID hardware (tags and readers).

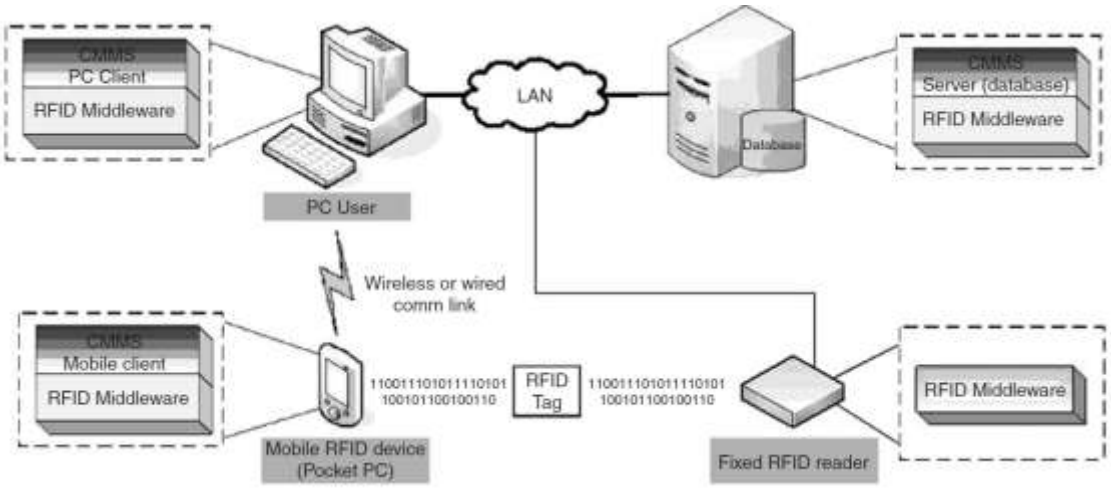

Figure 2. CMMS/RFID middleware interface (Bagadia, 2006)

5. Discussion and conclusions

One of the main reasons RFID technology is proliferating throughout nearly every sector of business is due to its very broad and diverse application set. RFID technology is able to provide significant efficiencies and value to industry-wide problems such as unique asset identification, security, verification and authentication, accurate recording of events, removal of manual data entry, and real-time data flow into enterprise applications—just to name a few.

The ability to identify any type of asset in a unique manner and to distinguish it from numerous other identical items has tremendous application potential. Ensuring the proper piece of equipment is assigned to the appropriate personnel, or associated with another piece of equipment, or required location can save time, reduce work stoppages, limit resource allocation, and eliminate costly mistakes. For instance, maintenance of aircraft often requires that certain parts, when disassembled, be reassembled with the exact components due to wear patterns. This can be a very tedious and expensive undertaking, but using the unique identification capabilities of RFID, the part associations can be done much more accurately and efficiently. Once a piece of equipment has been tagged and the unique RFID serial number has been linked to the asset record in the central database, maintenance personnel will no longer be assigned the responsibility of ensuring that they are working on the required piece of equipment.

Another great feature of RFID technology is the ability to store asset information directly on the tag. RFID technology can empower field workers to rapidly access required information and to make educated and informed on the spot decisions without having to consult with other individuals, manuals and printed media, or manufactures and suppliers.

By having an RFID tag installed on all pieces of equipment, workers can be empowered with immediate access to vital pieces of information that can allow them to do their job much more effectively and efficiently. The information that is stored on an RFID tag is completely definable by the user (or company) and is often specific to the process or equipment that is involved. This information can be mapped from the existing CMMS data fields to the memory map on the RFID tag. Common types of information that can be stored on the RFID tag are serial

numbers, make, model, drawing numbers, inventory levels, maintenance history, and maintenance processes.

Some common uses of RFID for inspection points occur where equipment is required to be certified or adhere to laws and standards. Such applications include the inspection and certification of fire extinguishers and high-pressure cylinders, emergency exit lighting and doorways, equipment in the oil and gas, or power generation sectors as well as safety inspections on various pieces of vital equipment in the healthcare sector just to name a few. Additionally, RFID tags can be used to tag locations that must be attended during security guard rounds. The scanning of an RFID tag can provide secure verification that a guard visited a given location as well as the exact time of the visit.

Most of the CMMS applications involving RFID have been centered around equipment and parts. However, RFID tags can be used to uniquely identify anything animate or inanimate. Another great use of RFID is to tag entrances/exits, rooms, or points of interest located within a facility. These tags can be used as information points to help individuals navigate through the facility or to provide information about the contents of a room. Once again the possibilities of using this technology are virtually endless and everyday people are finding more and more creative ways to create efficiencies in their organization by utilizing this great technology.

Another benefit of RFID is that all information that is collected and used is constantly in a digital format. Even information that is updated by field workers via handheld computers is stored in a digital format. This facilitates the rapid and virtually effortless synchronization of field data with the central CMMS database. The benefits are not limited to reduced costs and more accurate data (i.e., no manual data entry and automated data collection), but having real-time reporting and status updates of assets and operations enables management to make faster and more precise decisions regarding business operations. Additionally, costly problems and problem processes can be identified faster. Ultimately leading to a more efficient and competitive organization.

It is predicted that RFID offerings as part of a CMMS offering will become increasingly common within the next years. RFID will not begin to proliferate and become an industry standard in the CMMS application space until many of the major providers begin incorporating RFID into their product offerings.

Also, as the technology becomes the industry standard for automated data collection and successful use cases become more prevalent, equipment manufacturers will begin incorporating RFID tags and associated equipment information as part of their standard offering. This will mean that end users who purchase and use the equipment will not need to retrofit RFID tags on the equipment and it will lead to much closer relationships between equipment manufacturers and providers of asset/equipment management technologies. The final large influencing factor that will lead to the widespread adoption of RFID technology in the CMMS field will be the continued growth and expansion of mobile computing and real-time connectivity. As computing devices that can accommodate RFID technology begin being used much more profusely so will RFID technology itself. Furthermore, the ability to link data to the centralized CMMS database in near real time will justify having a means of

collecting data more rapidly and accurately.

The companies which will benefit most from RFID technology will be the early adopters gaining market advantages via process improvements, increased time and cost efficiencies, and innovative product offerings that create solutions for industry-wide problems, which in turn will lead to increased sales and revenue growth.

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