International Journal of Engineering Research-Online
A Peer Reviewed International Journal
Email:editorijoer@gmail.com http://www.ijoer.in

Vol.4., Issue.3., 2016
(May-June)

RESEARCH ARTICLE

ISSN: 2321-7758

STUDY ON IMPLEMENTATION OF RFID TECHNOLOGY IN CONSTRUCTION PROJECTS

ROHIT R. SARDE

Civil Engineering Department, Sinhgad College of Engineering, Pune, India

ROHIT R. SARDE

ABSTRACT

Equipment and Tool management, Materials management and Workforce management are the main contributing factors to the success of a Construction project. The management of equipments and tools faces issues such as loss of equipments and tools, difficulty in locating tools and equipments obscured by tall grass and deep snow, work safety hazards as well as selection and handling problems. Material management is made problematic by shortage of materials, lack of storage space, damage and storage, delay in material supply and price fluctuations. Identifying and organizing workforce, effective absence recording, onsite workforce monitoring and productivity issues adversely affect workforce management. This paper addresses potential applicability of RFID Technology for Equipment and Tool management, Materials management, and Workforce management. Initially, a literature review was conducted for exploring RFID Technology potential in above stated construction project management categories. In conclusion, the research reveals the need of implementing RFID Technology to enhance productivity and achieving cost optimization with time constraint in Construction projects.

Keywords- Construction Projects, Equipment and Tool management, Materials management, Workforce management, RFID

I. INTRODUCTION

Equipment and Tool management in a construction project must vigorously pursue the efficient utilization of equipments and tools. Reference [1] stated that on some construction projects, such as earthmoving and road projects, the hire costs of equipments can be significant and improving its productivity can improve the project's profit. Poor equipment management can adversely impact the project schedule, resulting in operating longer hours and impact on labour productivity. The traditional way for equipment management relies on human skills which may sometimes prove error prone, intensive and unreliable in case of large projects. This paper investigates a new approach, RFID technology based equipment management that can facilitate easy to implement solution to uniquely identify equipments and tools.

Material management is a vital management in construction projects to achieve better productivity and profits. The goal of material management is to ensure that materials are available at their point of use when needed and the right quantity and quality of materials are appropriate selected, purchased, delivered, and handled on site in a timely manner and at a

reasonable cost. Indeed, the management of materials will cause a huge effect on the total project cost, time and quality [2].

For effective material management, construction projects need to explore the advantages of ICT (Advanced information systems and telecommunications systems). ICT supports the direct and indirect purchasing with electronic payment. The elimination of paper work, lower product and operation costs, and reduced cycle times are some of the advantages of ICT [3]. This paper addresses material management from the RFID technology context.

Workforce management includes the proper utilization of available labor to complete the work on time. Labor productivity in construction is the amount of goods and services that a labor produces. For example, brick laying, pouring concrete, plastering. However, there are several factors that would affect the job-site productivity which are labor characteristics, project work conditions and non- productive activities [4]. Proper supervision and monitoring of labors is necessary. This can be enabled by implementation of RFID technology in workforce management.

The current practices in above mentioned management categories are executed manually and are mostly paper based. Automated tracking technology such as bar coding in tracking process is an accepted strategy. Bar coding provides up-to-date information to responsible personnel involved in a project [5]. Reference [6] has stated that data collection methodology has been developed that utilizes both bar coding and RFID technology to collect data of working hours and material quantities on construction sites so that stored data can be used for tracking project cost and schedule information. Eventually, an assembly of automated schedule monitoring system is utilized to control the erection process for precast building construction by integrating bar coding and GIS [7]. The given examples of bar coding have been successfully implemented on construction sites. But, the use of bar coding involves many constraints such as it can be damaged easily, obscure in direct sunlight and unable to sustain in harsh conditions [8]. This results in a necessity to consider emerging technology such as RFID technology. Recent developments analyze the viable utilization of passive RFID technology to automatically track the flow of structural components during shipping processes [9]. Hence, the specific study is concerned with the potential implementation of RFID technology in the construction projects.

II. RFID TECHNOLOGY OVERVIEW

1. Working of RFID

RFID Technology was first addressed in a paper by Harry Stockman, "Communication by means of reflected power" cited in Reference [10]. The RFID system consists of tags (transponder), a reader (interrogator), and a host terminal. The tags and reader are equipped with antenna. The components of RFID are as shown in Figure 1. The RFID reader acts as a transmitter and receiver and transmits an electromagnetic field that "wakes-up" the tag and provides the power required for the tag to operate [11].

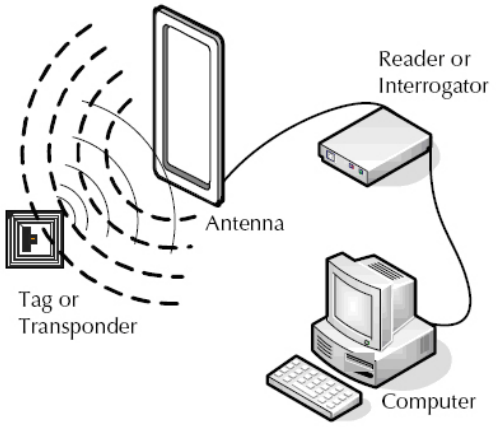

Figure 1.RFID System components

2. RFID tag

It is a portable memory device located on a chip that is encapsulated in a protective shell and can be embedded in any object which stores dynamic information about the object. Tags consist of a small integrated chip, coupled with an antenna, to enable them to receive and respond to radio frequency queries from a reader RFID tags are further classified as passive and active. Passive RFID tags have no power source as well as no transmitter. They have a shorter range of about a few inches to 30 feet [11].

Principal advantages of RFID tags over barcodes are:

a) RFID tags have unique code which enables to identify every item individually.
b) RFID tags are equipped with RFID reader which read the tags within the load, without having to physically move any of the materials or open the casing.
c) RFID tags can hold greater amounts of data than barcodes.
d) They are more durable and reusable making it suitable for construction sites.
e) RFID tags do not get damage easily as barcodes do.

A Passive RFID transponder consists of a microchip attached to an antenna. The transponder can be packaged in many different way as well as they can be mounted on a substrate to create a tag. They can also be embedded in a plastic container, and special packaging that resists heat, cold, or harsh cleaning chemicals.

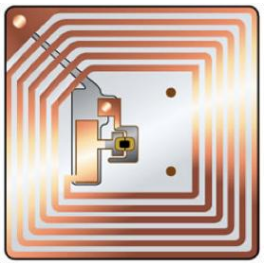

Figure 2.Passive RFID Tag

An Active RFID tag is powered by its own supply and is rewritable. They have a range of 300 feet and hence reliable. The cost of active RFID tag depends on the amount of memory and presence of on board temperature sensor. For large projects, active RFID tags are more preferable than passive RFID tags [12].

Figure 3.Active RFID tag

3. RFID reader

It consists of a radio frequency module, a control unit and a coupling element connected to the transponder [13]. Data exchange takes place between the tags and readers through radio waves. The reader can be fixed or mobile and capable of communicating data to tags and vice versa [14]. According to Reference [15], Personal computers, mobiles, tablets can be embedded with mobile reader. The RFID reader is enabled with an antenna for sending and receiving signals in order to give instructions and information to the reader through a scanner. Digital format of data from the reader can be used by computers for data analysis, recording and reporting. Market availability of reader includes i-Card 3 and i-PORT 3 (Identification rate 100 RFID tags/second).

Figure 4.RFID Reader

4. RFID Antenna

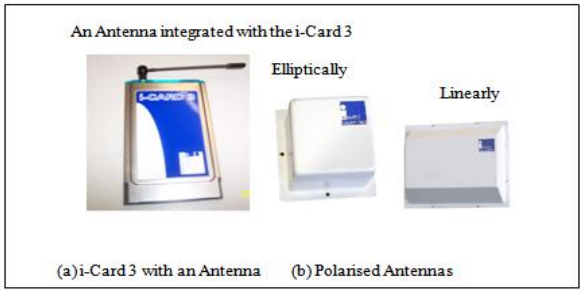

Figure 5.Types of RFID antennas

Reference [16] stated that the RFID antenna is a conductive element that enables the tag to send and receive data. The electromagnetic field which is transmitted by reader antenna activates the passive and active tags when it is within the range. Thus, enabling identification of the product to which tag is connected. The types of antennas are as shown in the Figure 5.

III. IMPLEMENTATION OF RFID TECHNOLOGY IN EQUIPMENTS AND TOOLS MANAGEMENT

RFID technology has flourished swiftly in manufacturing, retail, and distribution industries. The first implementation of RFID technology in construction industry was initiated at UK. The RFID tags were incorporated into boilers and doors also that can be used by most housing societies and facility management for asset management systems [17]. It has been observed that RFID is also useful in logistics tracking, quality control and waste reduction. The RFID systems can provide the construction industry with the potential to improve safety and economy, quality, reduction in material and labour costs, enhanced project schedules, and construction productivity [18].

Equipment and Tools management with RFID technology deploys tracking the numerous equipments and tools the crew uses at a construction site. The system enables the firm to know which equipments are where, thereby reducing the need to order or rent new items as replacements for equipment that cannot be located. Reference [19] further elaborates that such an attempt is made at North American Construction Group (NACG), based in Edmonton, British Columbia. The construction workers had a time consuming task whenever they searched for an equipment or tool. Equipments were either stored or used at various nearby construction sites .Tracking equipments was typically accomplished manually, with crews physically checking inventory levels and recording down serial numbers on a piece of paper. In the snow, it was a strenuous task to search for tools.

Hence, NACG adopted the Pilot project of RFID solution provided by Libramation, which initially was involved in providing RFID solutions to the libraries and oil industry. The RFID solution included total 40 equipments and tools on the construction site. It enabled to track the equipments and tools remotely from the office. Further, RDID solution was expanded and about 900 equipments and accessories were tagged with a value of $5000 or more. As soon as batch wise tagging was completed, equipments and tools were initiated in use on the site. The Identec ILR i-B2L tags were attached to equipments and tools. The tags having emission capacity of 915MHz signal were encoded with unique ID number, with a rate of about 1/2seconds, to Identec IntelliFIND handheld readers that construction crews operated on a daily basis. The tag's ID number was linked to the equipments serial number and identifying description in Identec software residing on NACG's back-end system, from a distance about 300 feet. At the end of the day work the location of tagged equipment was updated in the database.

In order to determine the location of an equipment the user inputs the description or serial number of the item being searched for, and the handheld's software then calculates the location of that item- or the closest item of that description based on previous recording, as well as the reader's GPS location at the time of those recordings. The handheld reader then displays an arrow pointing in that item's general direction. By walking in the direction of the arrow, the user eventually comes within read range of the item, at which time the system software recognizes the unique ID number on the RFID tag and begins to flash, thereby allowing the user to begin searching the equipment.

Thus, the tracking and monitoring system of RFID technology has enabled the construction organisation to effectively manage the equipments and tools located on the various construction sites at the same time from a remote location. This emerging technology will prove beneficial for equipment and tool management in construction industry.

IV. IMPLEMENTATION OF RFID TECHNOLOGY IN MATERIAL MANAGEMENT

It is certain that material management practices could increase efficiency in operations and reduce overall costs. Hence, special attention has to do in material management to obtain the successful completion of every project operation without difficulty.

According to the study conducted by Reference [20], the RFID applications in material management are as follows:

a) Up to date and accurate material status: Provide accurate information about shipping, receiving, and inventory to avoid

the items from missing, misplacement, or non receiving problems which adversely affect the project schedule.

b) Smooth material tracking: Current manual practice of tracking and delivering is sluggish and hence it needs to be replaced with more reliable RFID technology that enables to optimise planning on schedule critical tasks.

c) Inventory management: RFID technology makes possible real time, error free and automatic tracking and inventory of materials that are tagged with unique ID numbers. This technology effectively functions the supply chain right from transport to installation of the material.

The precursor research projects conducted in the context of RFID technology for material management include:

a) Tracking precast concrete components. [Ref 21]

b) Development of an RFID based automated model for material management. [Ref 22]

c) Planning of the materials for a water supply project located in complex operational environment. [Ref 23]

d) A model to track the percentage of materials utilised on the construction site. [Ref 24]

e) Tracking the steel tracks modular components from the fabrication site to construction site. For example, Gammon Construction Group, Hong Kong. [Ref 25]

V.IMPLEMENTATION OF RFID TECHNOLOGY IN WORKFORCE MANAGEMENT

Workforce management can contribute highly in reducing the project costs and increase productivity since significant percentage of labour cost is involved in a project. In context to this, RFID based solution can be implemented to track the number of workers on site, as well as their identities. By utilising the Workforce Monitor Service, construction project managers and supervisors can capture the identity f each worker entering or leaving a site, by means of Workforce Management Stations-RFID portals that reads RFID tags attached to the hardhats of workers.

Workforce monitor software application processes the data from readers related to individuals passing through the portal, providing a user with such details as which contractors have employees on site, the number of workers at the particular location, whether those personnel have the necessary training or certification required to be present, workforce demographics and the workers pin code. The RFID based solution also provides as which workers have gone belowground on sites in which trenches or tunnels. Thus, in case of emergency or occurrence of mishap, RFID technology can be used effectively [25].

The RFID based workforce management has been implemented for the construction of Washington Marriott Marquis Hotel, Washington D.C. Thus, implementation of RFID based workforce management proves to be a boon for construction industry.

VI. CONCLUSION

This paper evaluates the effectiveness of Equipment and tools management, Materials management and Workforce management supported by RFID technology based solutions in order to resolve the problems that the construction industry faces on work sites. It is observed that RFID technology has been successfully implemented on construction sites. This implementation has resulted in reduced project costs, proper project schedules, enhanced productivity of workers and better handling of equipments and tools. Utilisation of RFID technology in collaboration with current practices may prove efficient. It can be concluded that the emerging technology should be adopted by construction organisations. This paper identifies the potential for implementation of RFID technology in the mentioned categories of construction management.

REFERENCES

[1]. The successful contractor-Construction project management.[Online] Available:http://www.pn-projectmanagement.com/construction-

management-tips/the-impact-of-poor-equipment-productivity-on-projects , 2014.

[2]. Nann Lwin Phu and Aye Mya Cho, "Factors Affecting Material Management in Building Construction Projects," IJSETR, Vol.03, Issue.10, pp.2133-2137, 2014.

[3]. UKEssays (2015), Labour Management in Construction Projects Management Essay [Online].Available:https://www.ukessays.com/essays/management/labour-management-in-construction-projects-management-essay.php

[4]. M. Sun, and R. Howard, Understanding I.T. in Construction. Spoon Press, London, 2004.

[5]. Z. Chen, H. Li, and C.T.C. Wong, "An Application of Bar-code System for Reducing Construction Wastes," Automation in Construction, vol. 11, issue 5, pp. 521-533, 2002.

[6]. O. Moselhi, and S. El-Omari, "Integrating Bar Coding and RFID to Automate Data Collection From Construction Sites," Joint International Conference on Computing and Decision Making in Civil and Building Engineering, June 14-16, 2006, Montreal, Canada, pp. 1734-1741, 2006.

[7]. M. Cheng, and J. Chen, "Integrating Barcode and GIS for Monitoring Construction Progress," Automation in Construction, vol. 11, no. 1, pp. 23-33, 2002.

[8]. E.J. Jaselskis, and T. El-Misalami, "Implementing Radio Frequency Identification in the Construction Process," Journal of Construction Engineering and Management, vol.129, no.6, pp. 680-688, 2003.

[9]. D. Grau, L. Zeng, and Y. Xiao, "Automatically Tracking Engineered Components Through Shipping Receiving Processes With Passive Identification Technologies," Automation in Construction, vol. 28, pp. 36-44, 2012.

[10]. J. Landt, "The History of RFID," IEEE Potentials, vol.24, issue 24, pp. 8-11, 2005.

[11]. J. M. Sardroud, "Influence of RFID technology on automated management of construction materials and components," Scientia Iranica, vol. 19(3), pp.381-392, 2012.

[12]. RFID Journal (2007) The Basic of RFID Technology. [Online]. Available: http://www.rfidjournal.com/article/articleprint/1337/-1/1

[13]. K. Finkenzeller, Fundamentals and Applications in Contactless Smart Cards and Identification, 2nd edition. John Wiley and Son, England, 2003.

[14]. C.R. Wood, and M.W. Alvarez, Emerging Construction Technologies A Fiatech™ Catalogue. FIATECH™ , 2005.

[15]. M. Schneider, Radio Frequency (RFID) Technology and its Application in the Commercial Industry. Master's of Science in Civil Engineering, University of Kentucky, 2003.

[16]. K. Sohraby, D. Minoli, T. Znati, Wireless Sensor Networks: Technology, Protocols, and Applications, pp.328

[17]. Innovation & Research Focus (IRF), IT & Construction Process: Reports on Radio Frequency Identification (RFID), issue 67, pp.6, 2006.

[18]. M. Schneider, Radio Frequency (RFID) Technology and its Application in the Commercial Industry. Master's of Science in Civil Engineering, University of Kentucky, 2003.

[19]. RFID Journal (2013) Construction Group Improves its Ability to Find Heavy Equipment [Online]. Available: http://www.rfidjournal.com/articles/view?5349

[20]. C.R. Wood, and M.W. Alvarez, Emerging Construction Technologies A Fiatech™ Catalogue. FIATECH™ , 2005.

[21]. B. Akinci, M. Patton, and E. Ergen, "Utilizing Radio Frequency Identification on Precast Concrete Components - Supplier's

Perspective," Proceedings. ISARC'02, IAARC, Washington, DC, pp. 381-386, 2002.

[22]. R. Navon, and O. Berkovich, "An Automated Model for Materials Management and Control," Construction Management and Economics, vol. 24, no. 6, pp. 635-646, 2006.

[23]. Z. Ren, L. Sha, and T.M. Hassan, T.M., "RFID facilitated Construction Material Management - A Case Study of Water Supply Project," Proceedings of the 24th CIB W78 Conference Information Technology in Construction, Maribor, Slovenia, pp. 401 – 406, 2007.

[24]. A.A. Ghanem, Y.A. AbdelRazig, and S.M. Mahdi, "Evaluation of a Real-Time Construction Project Progress Tracking, Sustainable Development through Culture and Innovation," The Joint International Conference on Construction Culture, Innovation and Management (CCIM), 26-29 November, Dubai, pp.771-780, 2006.

[25]. RFID Journal (2013) Gammon Steel Tracks Modular Components for Buildings [Online] Available: http://www.rfidjournal.com/articles/view?10287