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USE OF TECHNOLOGY IN MATERIAL TRACKING IN THE CONSTRUCTION INDUSTRY BUSINESS

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ABSTRACT

Construction industry consumes tons of material each year. A single project requires different types of material at different phases of construction. During each phase, the material needs to be tracked for a variety of reasons. Although several material tracking technologies are available that have gradually improved over the past decade, their application to construction industry is limited. Lack of proper construction material tracking on site, significant time, monies and efforts are wasted in counting, documenting, identifying and locating the required materials and thus decrease in efficiency and productivity. The objective of this paper was to review potential application in construction material management, identify current practices and developing industry wide standards for harnessing the benefits of implementing Radio Frequency Identification (RFID) technique as material tracking technique. RFID technology has been successfully used in construction (and several other businesses). This technology has a promise for extensive application to construction industry. A review of literature indicates that RFIDs have been used for material management and small tool management on construction projects and also discussed the barriers to its application. By using the experiences from other industries using similar technologies, combined with the expertise of suppliers within the RFID industry with experience of the distinctive needs of construction, it soon becomes clear that RFID has an important contribution to make to the performance of contractors, component suppliers and other players in the construction industry.

Keywords: *Technology, RFID's, Material tracking, Construction*

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Introduction

Technology in different sectors has improved in the recent past. Both in construction and manufacturing, technology has improved even though to different degrees. Some of the reasons cited for the differences in the use of technology between manufacturing and construction is by the mere fact that construction rarely involves production of a standardized product. Construction operations are repetitive but they are not undertaken in the similar sequence or at a fixed location. It is for these reasons among others that unlike manufacturing, the construction projects end up with a complex material supply function of buying, expediting, receiving, warehousing and delivery. Materials plays a big role in the construction process. According to Song and Caldas, 2006, construction materials account to about 50-60% of the total construction project cost. It is therefore because of this reason that material tracking will be a central point to be considered by all players in this business. The complexity of material tracking and management is directly proportional to the project size together with such factors like storage space and handling facilities.

Locating and tracking materials in construction jobsites has been reported as one of the problems facing many construction players (Song, 2005; Navon &Berkovich, 2006; Nasir, 2008). Song (2005) reported that tracking and recording and locating materials is important in site organization and ensures that materials are available when needed which is key to avoiding any wastage. Material tracking has received attention from many researchers and practitioners alike because most of the construction materials are received in bulk without proper identification and records. If materials are not properly handled, managed and stored on site, it means that in most cases the information available regarding materials is not reliable. It makes it difficult to locate materials at the jobsite when needed.

The traditional methods used to track construction materials have several limitations and hence need to incorporate technology. These limitations can be effectively addressed by using readily available material tracking techniques necessitating the use of material tracking devices like Radio Frequency Identification (RFID) and bar code scanning techniques which have been successful in other sectors to be used in tracking construction materials. These technologies have a promise for extensive application to construction industry. Thus, this paper will review potential application in construction material management, identify current practices and developing industry wide standards for harnessing the benefits of implementing Radio Frequency Identification (RFID) technique as material tracking technique.

Construction material management issues

Construction industry consumes tons of material each year. A single project requires different types of material at different phases of construction. During each phase, the material needs to be tracked for a variety of reasons. For medium to large sized projects in the world, material could be coming from more than one contractor. During the construction phase, the required materials and components (such as prefabricated concrete blocks or assembled parts of steel) are stockpiled on site and used whenever needed. Significant time, monies and efforts are wasted in counting, documenting, identifying and locating the required materials on site. These issues decrease the overall efficiency of construction crews leading to overall increase in project costs. Similarly, during the operations and maintenance phase identifying a contractor responsible for defective material could be very difficult especially for projects stretching several

decades mandating long-term asset performance - a very common requirement for highway projects these days.

In his research, Sardroud (2012) asserted that inventory management during a construction process could be affected by many factors such as inadequate storage space, double ordering, over ordering and incomplete and lack of up-to-date information regarding on-site stock. Navon &Berkovich (2006) attributed the lack and incomplete of up-to-date information regarding on-site stock is caused by the poor tracking and locating of materials in construction sites. Thus, there is a need for a proper inventory management in order for the materials to be tracked and located easily; and without employing additional costs.

To track materials needed to deliver a construction project is not an easy task. In their research, Navon &Berkovich (2006) contented that tracking materials is still a big problem facing the construction businesses at the jobsites. This process of tracking construction materials is complicated by the large amounts of materials and components involved in the development process. Besides that, an on-site material tracking is also bound with the traditional-manual method (El-Gahzali et al., 2011; Kasim, 2010; Jang &Skibniewski, 2008; Navon &Berkovich, 2006), which has several limitations. These limitations that these techniques have make them unsuitable to be used in construction projects which demand a prompt action primarily in decision making process.

The limitations to traditional material tracking methods include labor intensive, inaccurate and subjected to error prone, which further leads to waste and surplus of materials, schedule delays, decrease in productivity, and the lack of up-to-date information regarding the status of materials (Navon &Berkovich 2006). In their study, Sardroud et al., (2010) supported this argument by adding that the data obtained and passed regarding the status of the materials is dependent of the labor handling it and as such influenced by their motivation and skills. Traditional material tracking techniques also involve a manual process. Furthermore, these techniques and information on materials are take a paper-based format, which is difficult to be trace and access in the future. The negative effect of this is that some information ends up being unavailable to theconstruction players and stakeholders who need access to them in a timely manner; for project success (Sardroud et al., 2010).

Grau et al. (2009) described the traditional process of tracking materials as having the materials first being loaded onto a truck, then the materials are hand-marked and issued with a delivery note which will be used at the jobsite for identification when delivered. At the jobsite, the receiving workers will mark the items received against the delivery note and stored within the yard. This process does not provide an assurance for future identification of these materials. In most cases some materials are left scattered all over the place at the construction site. Another problem encountered is when the materials have been used with some being left at different locations within the site without being properly recorded and returned to their specific locations (Ergen&Akinci., 2007). These scenarios raise difficulties among the workers in the construction site to access the required materials when they need them and as sucha lot of working time is wasted in searching for the materials. It also contributes to poor site inventory management which further result in time and costs overruns.Kasim et al (2012) proposed real-time materials tracking process with employment of RFID in improving materials tracking and overall process of materials management on the construction sitein order to overcome these problems. Hence, a good materials management environment

enables proper materials handling on construction projects.

RFID Technology

It is likely or a common practice that when one purchases goods at a retail shop that it will have RFID tags on them. The technology has seen a rapid growth in its use in several industries such as retail and manufacturing. Mostly this is for supply chain management to track the shipment, for inventory management and/or prevent theft. In his research, Hannon (2007) reported that innovation relation to RFID is advancing fast. It is now possible to have tags that are capable of receiving and sending data at the same time which is likely to completely replace bar code scanning operations. This technology is not new in construction industry in countries such as USA. According to Schneider (2003) the transportation construction industry in USA employed the use RFID in equipment identification, toll fare collection, fleet management, railcar management and fuel dispensing.

How RFID Works

RFID is a universal term given to any technology that uses radio waves to identify and track items. The primary components of an RFID system are shown in Figure 1. This system requires tags and readers which includes an antenna for it to function. The small chips referred to as tags have the ability to send data signals through radio waves and are attached to physical items or materials to be identified. They are also called transponders. The data signals are received by an "interrogator" or "reader" for interpretation of the tag's data(Hannon, 2007). Readers can be stationary or mobile (HHC). The RFID reader or interrogator provides, read and write/read facilities through a fixed or mobile reader to communicate data to and from the tags.

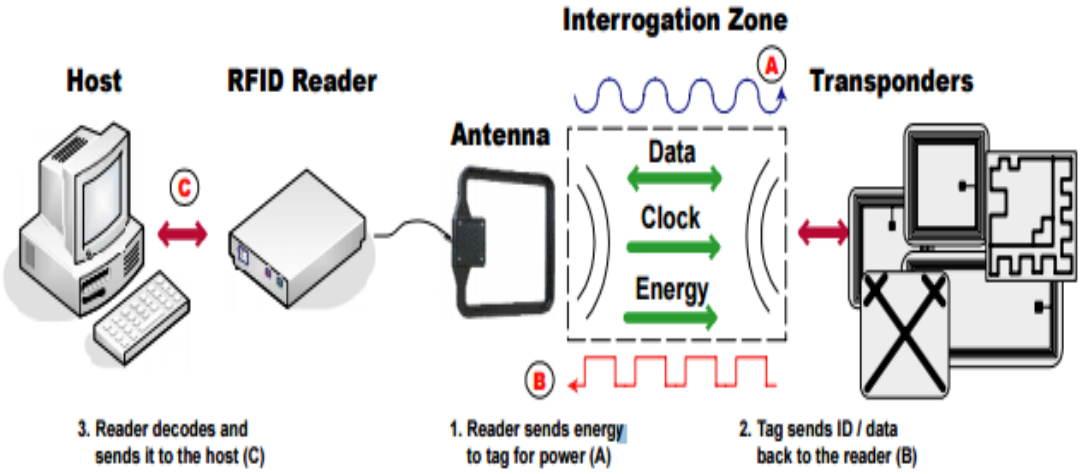

Figure 1: How RFID works. (Source:Prabhu et al, 2003)

Research interests in RFID in construction

Wang, et al (2007) argued thatin order to obtain real-time information and information sharing among the involved participants of the construction supply chain, some research efforts have to be made focusing on RFID technology. A number of authors have looked at the automation of material management and specifically on the application of RFID based techniques (Caron et al, 2007, Grau et al, 2009, Jang and Skibniewski, 2008 and Wan and Kumaraswamy, 2009). Other authors who have contributed to this area of research include; Song et al (2006) who

looked at the application of RFID in tracking, delivery and locating fabricated pipes, Torrent and Caldas (2009) focusing on structural steel members, Tzeng at al (2008) investigated its application in interior decorating materials, Ergen and Akinci (2007) reported on engineered to order components while Wang (2008) documented the application of RFID in quality management. The ERA Build project (2006) identified a number of application areas where the research or visionaries within the construction industry were pointing the way forward (Table 1).

Table 1: Areas of research interests

Current applications	**Future/Areas of interest**
Tracking items through production	Inventory management
Quality control in production delivery and construction.	Logistics for just-in-time delivery or customer managed inventory
Operational control in production; for example, by ensuring compatible components are used together.	Product identification and traceability
Access, safety and security control on sites	On-site inspection
Facilities management of sites	De-construction management including managed materials disposal
Tracking and tracing rental items	Tracking and locating of construction materials.
Asset management, including real time location of assets.	

RFID Technology in Construction Materials Management

RFID technology usage has been on an upward trend in the past few years in industries such as manufacturing, retail, distribution and etc. However, there has been a limited application in the construction industry. Some countries especially developed countries have shown interest in using these technologies in their construction sectors (Kasim et al, 2012). RFID applications have been carried out into in quality control, logistics tracking, system or component build, waste reduction, and asset management. RFID technology is becoming cheaper and should offer construction new opportunities to improve maintenance of assets.

According to IRF (2006), RFID is a versatile, extensively used and proven technology for tracking items in several sectors. The report further stated that this technology can be used to provide data on the whereabouts of materials, track the history of their use, and help control where they can (or cannot) be used. The technology can also be used to give information on how consumable materials have been used and provide the means to track these items or goods throughout the supply chain. These applications in tracking construction materials offer potential benefits to the business which can, in turn, be translated into a valuable return on investment for the construction projects. These benefits include:

- Hassle free documentation of operations, maintenance, repair history and warranty claims.
- Availability of onsite operational support through availability of personnel data, timekeeping, fleet management and progress status.

- Instant and easy data availability to decision makers and administrative staff.
- Reduced paper work and related hassles.
- Convenient digital data storage, analysis and transfer.

In the IRF (2006) report, the advantages realized through the application of RFID's translate into financial benefits that provide the basis for a return on investment in the following areas.

- Reduced inventory costs through "just in time" delivery to site
- Lower asset costs for tools and equipment through better utilization due to better material management
- Less "shrinkage" in inventory and asset base
- Less time lost to industrial injuries, lower compensation payments
- Lower sub-contractor costs through better material control

Barriers to Implementation

Although the techniques are beneficial several barriers exist that prevent their widespread adoption and implementation. These barriers are as follows:

- ***Cost of Implementation:*** Over the past decade the cost of these techniques have reduced significantly. However, this cost could still be higher than manually counting, documenting, identifying and locating materials.
- ***Training:*** Additional training is required to efficiently use these techniques but hindrances are observed due to employee resistance and additional costs.
- ***Institutional Support:*** Organizations' willingness, support and preparedness for adopting these techniques are necessary but currently it is minimal.
- ***Operational Challenges:*** Barcodes are vulnerable to moisture and the reading devices have visibility issues in direct sunlight. On the other hand, RFIDs are affected when obstructions are present between tag and the reader. Other issues such as tag readability and multiple frequencies could also make these techniques erroneous.
- ***Industry Standards:*** Lack of industry wide standards makes it virtually impossible to use these techniques seamlessly across the supply chain and sometimes through the various phases of a single project.
- ***System Integration:*** Software interoperability issues and IT systems integration issues could discourage widespread industry acceptance.
- ***Data Risks:*** Some inherent risks of tempering, fraudulent tags and readers, data breach and misuse still exists.

Conclusion

It looks like a universal agreement that RFID technology has a widespread application in construction industry and that its benefit is real. This paper discussed issues in construction material management, the RFID technology and its use in construction material tracking. The paper further discussed the benefits of employing RFID in construction material management together with its benefits on ROI. The current practices on the use of RFID technology is improving effective management of construction materials at the jobsite.

Barriers discussed in the paper tend to play against its widespread use in the industry. Overall, the dilemma faced by construction players is where to apply the technology due to its wide range of uses in the industry. This explains why the emergence of a pool of expertise and a universally

recognized best practice has been slower compared to other sectors. Thus, as it stands today many proponents of the technology faces similar challenges in arguing a strong business case on the benefits of the technology based on the ROI. Even so, by using the experiences from other industries using similar technologies, combined with the expertise of suppliers within the RFID industry with experience of the distinctive needs of construction, it soon becomes clear that RFID has an important contribution to make to the performance of contractors, component suppliers and other players in the construction industry.

The initial costs of setting up RFID technology can be quite low. Going forward in applying its use in construction material usage, using a demonstrator may prove to be the easiest, quickest and least risk way to assess feasibility and to identify the likely benefits and potential pitfalls of an implementation. Piloting the technology can be the best way to assess its potential contribution.

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