

AUTOMATED MATERIAL MANAGEMENT THROUGH RFID TECHNOLOGY IN CONSTRUCTION INDUSTRY: A REVIEW

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Abstract: This review paper delivers information on Radio-Frequency Identification (RFID) and its possible uses in the material management in construction industry. Current study has showed that even though materials may create more than 50% of entire costs of project, existing approaches for handling them still depend on human expertise. This old-fashioned collection of data is labour-intensive and time consuming and untrustworthy, due to the reluctance of labour forces to examine and record the existence of bulky material. Automation in the task of recognizing construction materials on site can provide well-timed and precise information on materials presented to the manager. Generally, to mitigate the labour error and other error we are not using emerging technologies such as bar code, RFID and wireless system. We are not able to coordinate these technologies with project management system to make material management quicker and easier. These technologies are not well incorporated with Project Management (PM) system. Thus, this study seeks to recognize the possible employment of that technology focusing on Radio Frequency Identification for management of materials in construction industry. In this paper, a literature review on materials management problems and identifying RFID application in materials management was conducted. At the end, the study found that, more attention required towards the material management to improve the material management processes on site in the future.

Keywords - Material Management, Radio Frequency Identification (RFID), Automation, Project

I. INTRODUCTION

A main difficulty that harmfully hampers the project performance is the inadequate management of construction materials throughout site activities. There is a major role of material management on site for the performance of project. There are many problems which affect the management of construction material such as material procurement, storage areas. Material handling and material distribution are also major problems on site. Past research has also showed problem related material management like requirement for big storage capacity, logistic problems and inadequate storage for material. Other problems include manual tracking of material on site, late delivery and lack of material.

Radio Frequency Identification has the ability to enable management processes of material for large scale construction works. RFID also has the ability to store a big amount of information in comparison of bar-code system. Radio frequency identification can also be helpful in decreasing paperwork and can also be incorporated with other uses such as project management systems. It will make management and tracking of material quicker and easier.

II. CRITICAL LITERATURE REVIEW

The following are the previous literature review on the basis of material management and application of RFID technology in construction industry.

2.1 Literature Review on Material Management

The following are the previous literature reviews on the basis of material management in construction industry.

Khyomesh Patel et al. (2011) examined a different study to find the problems made by the nonexistence of appropriate management of construction material on site. In Ahmedabad research has been done. Author has done study with careful from the beginning of the project to the end of the project. After examined each and every step, the problem could be identified. Author established that, the team coordination among the organization and site, appropriate control, monitoring of the system, awareness and accountability, efficient management information system integration will end in better result. (8)

Georgekutty et al. (2012) carried out a literature study based on incompleteness of construction project. In Kerala region, a questionnaire survey was done. From the survey and study, major factor that influence the project performance could be mitigated by following proper material procurement and pre planning. By doing this exceeding cost of the project could be cut down. (4)

Phani Madhvi et al. (2013) had carried out a case study on construction site for management of material. The main aim of the case study was to recognize the problems arise in the construction firms because of the inappropriate uses of material management. Inventory controlling, procedures of procurement, tracking of material and cost, on this factor analysis was done on. Goods were examined by First In First Out (FIFO) technique. Always Better Control (ABC) analysis was used for the cost estimation. From the study, data were collected and new appropriate technologies implication were introduced like Personal Digital Assistant (PDA), Radio Frequency Identification (RFID) which helped us in an appropriate financial control and scheduling. (13)

Nwosu Hyginus Emeka et al. (2014) studied the effect of material management in Nigeria brewing firms. Total strength of the staff was 4648 in Nigeria Breweries and Guinness Nigeria PLCs. From that total strength three hundred and sixty eight was selected for study of profitability of firm. For the test of hypotheses Z-statistics was used. From the analysis, it was found that material storage, material inventory, material procurement has a significant impact on the profitability of brewing firms. From this, it was concluded that effective material management is indispensable to brewing firms in making profits. (9)

Olusakin et al. (2014) studied the effect of management of raw material in production procedure. He was known about the ineffectiveness in management of raw material and the alternative solution to mitigate the problem. Authors establish the coordination between raw material and inventory management to resolve the crisis. By this study he establish that ineffectiveness was due to uneducated and non-expert involvement in material management, handling of material and incapability to use appropriate inventory model on site. (10)

Anup Wilfredd et al. (2015) had done a case study on residential project for material management. These case studies were done to find out the difficulties arises due to the inappropriate management of material. Due to these difficulties, cost of the project will be rise. So for the analysis point of view he has done ABC analysis and S curve analysis. A whole study of quantity of goods used was done by ABC analysis. Deviation in the project was found out by S curve analysis. From these analyses appropriate actions were taken. (12)

Boopathi et al. (2016) examined the real time residential project for material management. He had an opinion that improper material management increases the cost of the project. So in this project PRIMAVERA software was used for planning, scheduling and accounting. There was no increase in the cost of the construction project as he had followed an appropriate scheduling method. The material cost constitutes the fifty per cent of the total cost which is normal. (7)

The following table 1 shows the different errors identified during the material management by different authors.

Table 1 Material Management Errors Identified in different Research Papers

Author & Year	Transaction errors	Delivery errors	Scanning errors	Theft	Administrative errors	Misplacement	Supply errors
Lightburn (2002)	*		*			*	*
Chappell et al. (2003)		*		*		*	
Tellkamp (2003)	*		*	*			
Kang et al. (2004)	*		*		*		*
Lee et al. (2005)	*			*	*		
Atali et al. (2006)	*		*	*			*
Basinger et al. (2006)	*		*				
Sarac et al. (2008)	*		*			*	
Kok et al. (2008)	*		*		*		*
Kim et al. (2008)		*		*			

(*) Indicates identified error in reference paper

2.2 Literature Review on Application of Radio Frequency Identification (RFID) in Construction Industry.

The following are the previous research reviews on the basis of application of RFID technology in construction industry.

Jaselsekis et al. (1995) studied the information on radio frequency identification technology and application of RFID in construction sector. They discussed the use of three uses of radio frequency identification technology in the construction sector; processing and handling of concrete, coding of cost for workforce and equipment, and control of materials. Authors also noticed that companies of construction could possibly save time, money, and effort with the implementation of radio frequency identification technology in some working procedures. One problem was that the read-rate was too poor for field deployment. (5)

Perdomo-Rivera et al. (2004) found that contractor companies in construction field are using conventional material management practice with undefined communication and no defined responsibilities between the construction parties which are involved in construction. This type of problems makes rooms in information and it will affect the process of decision making and lead to the delays in procurement and receiving of material. (11)

Weinstein R et al. (2005) studied that RFID passive tag can transmit signal continuously or it can transmit when required. RFID passive tag reader can catch an electromagnetic signal from tag through its antenna, when tag moves across the reader's range. After that tag will keep the energy in capacitor from the signal. Inductive coupling is the name of this process. Once the capacitor charged, it can be able to power the circuit of radio frequency identification technology tag. The return signal from the passive tag consists of information stored in the tag. (14)

Forrest et al. (2006) told that, for tracking inventory in the supply chain RFID technology is a valuable technology. RFID technology can coordinate between physical flow of construction material and information throughout the supply chain from distributors to retail outlet and to the end users at the right time and place. Same as above it can also track the record of returned material by the supply chain and avoid fake record. RFID technology is irreplaceable for improving inventory management and efficiency of supply chain. (2)

Ju Hyun et al. (2013) demonstrated the framework to Information Lifecycle Management (ILM) with RFID for control of material. Author found that with the help of RFID technology, how to manage composite building material and also found that how to build combined information flows at different lifecycle stages. Material control can be achieved by ILM framework and RFID, which was validated by on site trials. At the end author concluded that with the help of RFID, precise and real time management of construction can be achieved in the construction industry. (6)

Enrique et al. (2016) reviewed that by implementing RFID into the construction industry, it will make construction of building easier. It will also make large number of processes automatic during lifecycle of a building. He also demonstrated that the integration of RFID makes the system efficient and accurate. At the end author concluded that there RFID technology has several limitations and gaps which force contractor to adopt other available technology. (1)

III. DIFFERENCE BETWEEN DIFFERENT TYPES OF TECHNOLOGY USED IN MATERIAL MANAGEMENT.

Following table 2 shows the difference between different technologies used in material management.

Table 2 Difference between Different Types of Technology

Parameters	Barcode System	Voice Recognition	Smart-Card Technology	Biometry	RFID Technology
Quantity of data (bytes)	1 to 100	–	16 to 64k	–	16 to 64k
Readability by people	Limited	Simple	Impossible	Difficult	Impossible
Dirt Influence	Very high	–	Possible	–	No effect
covering Influence	Total failure	No effect	–	Possible	No effect
Cost of Purchase	Very low	Very high	Low	Very high	Moderate
Operation cost	Low	Nil	Medium	Nil	Nil
Speed of Reading	Low ~4s	Very low >5s	Low ~4s	Very low >5-10s	Very fast ~0.5s
Influence of direction	Low	–	Unidirectional	–	No effect

IV. CONCLUSION

From the above literature reviews following conclusion can be made.

1. Effective use of Information and Communication Technology (ICT) technology in construction industry can increase field management of material, identification of materials and construction resources tracking.
2. By decreasing wastage and no. of lost items, it decreases the cost of construction material, time saving is also being observed.
3. Radio Frequency Identification readers are capable of reading tag information at a frequency of up to One Thousand tags per second.
4. The project risks are reduced when materials are visible, traceable, and controllable.
5. Radio Frequency Identification tags can operate efficiently in temperatures fluctuating from -40°C to 200°C.
6. Multiple products can be scanned simultaneously with Automatic Non-Line-of-Sight scanning.

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