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Dynamic mobile RFID-based supply chain control and management system in construction

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Abstract

Construction project control attempts to effectively obtain real-time information and enhance dynamic control and management via information sharing and analysis from involved participants of the projects to reduce construction conflicts and project delay. However, extending the construction project control system to job sites is considered inefficient since construction sites are unconventional practice. Integrating promising information technologies such as radio frequency identification (RFID) technology, mobile devices-PDA and web portals can help improve the effectiveness and convenience of information flow in construction supply chain control systems. Radio frequency identification is appropriate for various construction applications, and provides cost savings through increased speed and accuracy of data entry. This study demonstrates the effectiveness of a RFID-based supply chain management application called the mobile construction RFID-based dynamic supply chain management (M-ConRDSCM) system in construction projects, demonstrating that it responds efficiently and enhances the information flow among offices and sites in a construction supply chain environment. The M-ConRDSCM system is then applied to a selected case study involving a High-Tech factory building in Taiwan to verify the proposed methodology and demonstrate the effectiveness of information sharing of project control in the construction phase. The advantage of the M-ConRDSCM system lies not only in improving work efficiency for on-site engineers, but also in providing dynamic operation control and management to enable project participants to control the whole project. Moreover, this study presents a generic system architecture and its implementation.

Keywords: Supply chain management; RFID; Construction project; Web-based; PDA

1. Introduction

The construction industry is extremely complex because total project development generally comprises several phases, thus requiring a diverse array of specialized services and the involvement of numerous participants. Therefore, controlling and managing construction projects effectively are extremely difficult owing to the involvement of various participants. Real-time monitoring and control for the construction project may be necessary and helpful in completing projects comply with project budget and deadlines. With the advent of the Internet, web-based information management solutions enable information dissemination and information sharing among project participants. Generally, construction managers and on-site engineers require access to the construction site to manage a construction project since most such project are operated at construction sites. However, current desktops and notebooks are not suitable for using on construction sites because of problems in transportability. On-site engineers generally handle various types of digital information, including drawings, specification, checklists and daily reports. On-site engineers generally use sheets of paper and/or field notes. Consequently, a time and space gap exists between the construction site and the office, which reduces efficiency and creates a lack of data and data confusion.

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Information technology (IT) is important in successfully controlling and managing construction projects, particularly in enhancing communication and coordination among participants. Communication and coordination must be maintained to support resource and competency sharing within the network of a construction chain or the construction chain network. Furthermore, integrating promising information technologies such as personal digital assistants (PDA), radio frequency identification (RFID) scanning and data entry mechanisms, can help improve the effectiveness and convenience of information flow in construction supply chain systems. This study presents a novel system called mobile construction RFID-based dynamic supply chain management (M-ConRDSCM) system for improving the acquisition of construction information on site and providing an information sharing platform among all participants of the construction chain using web technology and RFID-enabled PDA.

1.1. Problem statements

Project management and control performance can be enhanced by enabling participants to share information with each other. However, two major key aspects of information sharing are information acquisition and information communication. Information acquisition problems in a construction project follow from most of the data and information being gathered from the construction site, which is an extension of the construction chain. The effectiveness of information and data acquisition influences the information flow between the office and the construction site. However, on-site engineers generally use written documents, drawings, contracts, specifications and shop drawings for job sites. Consequently, a time and space gap between the job site and the office causes duplication of data and information, lack of data and information, and associated confusion. Restated, existing means of processing information and accumulating data are not only time-consuming and expensive, but also compromise project management performance in information acquisition. Furthermore, construction contractors normally depend on interactions via telephone or fax to communicate with suppliers, subcontractors and designers. Consequently, transactions are frequently lost or misunderstood. Such means of communicating information between sites and offices, and among all participants, are ineffective and inconvenient.

1.2. Research objectives

This study develops mobile construction RFID-based dynamic supply chain management (M-ConRDSCM) system to improve efficiency and cost effectiveness of project control, improve practical communication among participants, and increase flexibility in terms of project delivery and response times. M-ConRDSCM system is a web-based system for effectively integrating general contractors, subcontractors and suppliers, to produce and distribute construction materials in the appropriate quantities, to the right locations and at the right times. Data collection efficiency can also be enhanced using RFID-enabled PDAs to enter and edit data on the job site. By using web technology and mobile devices, the M-ConRDSCM system for general contractors has tremendous potential to increase the efficiency and effectiveness of information flow, thus streamlining construction processes with other participants. The main purposes of this study include (1) applying such a system that integrates RFID technology with PDA technology to increase the efficiency of job site data collection; (2) designing a web-based portal for construction supply chain control, providing real-time information and wireless communication between offices and sites, subcontractors and suppliers; (3) providing on-site engineers with updated information, accessed via the internal supply chain control system between the office and job site, and (4) supporting project managers of each partner in monitoring and controlling the construction process dynamically. Fig. 1 illustrates solutions used in a real example involving construction in a High-Tech factory building in Taiwan. With appropriate modifications, the M-ConRDSCM system can be utilized at any construction site for contractors or suppliers in support of the M-ConRDSCM system.

2. Supply chains of construction projects

Supply chain management (SCM) originated from the manufacturing industry. The first visible signs of SCM were in the just-in-time (JIT) delivery system, as part of the Toyota Production System [16,15]. The supply chain has been defined as "the network of organizations that are involved, through upstream and downstream linkages, in various processes and activities that produce value in the form of products and services" [3]. SCM is the supply chain management from sourcing raw materials to final delivery to the consumer, and focuses on minimizing the time taken to perform each activity, eliminating waste and optimizing response by maximizing value [14]. Tserng and Lin [21] combined the quick response mechanism of information technology with portfolio theory in financial management to develop the accelerated subcontracting and procuring (ASAP) model for construction supply chain management. Organizations do more than merely managing their own portion of the supply chain. The process generally involves suppliers and demands, and ancillary organizations.

Supply chain control (SCC) is an integral aspect of supply chain management. Supply chain control in construction generally comprises a group of companies and individuals working collaboratively in a supply network of interrelated processes or activities designed to effectively satisfy end-customer needs while rewarding all members of the supply chain [1]. Supply chain control in construction is recognized to improve information flow, save costs, and support revenue-enhancing business strategy.