

APPLICATIONS OF PRC (PDA, RFID, CAMERA) IN CONSTRUCTION MONITORING

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Abstract

Currently, the prevalent data collection method in most construction firms focuses on document based approach which leads to excessive cost, time and manpower of projects. Activities such as Information sharing, production tracking, progress measurement, resource management and safety control can be performed more efficiently by using an automated data-based management system. This paper focuses on developing a method for data collection, called PRC in which a trilateral interaction among widespread technologies(PDA, RFID and camera), is used to obtain data from the job site and transfer it to a web based system where all the parties involved can access to this information subsequently. This system provides daily data, procurement data and visual data through the use of PDA, RFID and Camera installed on site, (PRC Data Collection System), which assists the project management team to fulfill their objectives, monitor and control the project more precisely and effectively.

Keywords: Construction Monitoring, PDA, RFID, Camera, Data Collection.

1.Introduction

One of the major responsibilities of a project management team in construction industry is to finish the project within the budget, time and quality stipulated in the contract documents. As the time goes by, the construction process gets more complicated, hence controlling all aspects of a project requires a bird's eye view over the project. One of the key factors in the success of this end is having an efficient and organized system of collection and dissemination of information from the job site to the parties involved. The common data collection method applied in most construction firms today is document based approach in which individuals are assigned to obtain data from different parts of the construction site. Many different types of construction data are typically collected in the field, often on a daily basis. Traditionally, onsite data collection have been recorded through the use of paper forms, a method still commonly used in today's construction industry as well. Once a site representative has collected all information, these forms are usually sent back to the office where they are manually sorted. Additionally, forms can be processed further by copying desired information from multiple forms into one form or even into a computer spreadsheet. A calculator or spreadsheet program may be used to further analyze the data to produce reports. Some type of filing method for the collected information usually follows. Forms are most often categorized and stored in a filing cabinet, ready for retrieval at a later date. Time spent in

collecting, filing, and distributing paper forms in this manual process raises many concerns, however. Not only is the clerical expense of the process very high, but also the organization and review of the information commands an inordinate amount of time by a project manager, of which most project managers possess very little (Perdomo, 2006). In response to such concerns, a first attempt to solve this problem is to transfer the information once collected to a computer database where it can be viewed, manipulated, and distributed electronically.

The proposed system is based on new technologies like PDA and its integration with other technologies such as RFID and cameras, in which accurate information can be gathered from the job sites and transferred to a web based system which all the parties can access to it subsequently. This system provides diary data, procurement data and visual data through the use of PDA, RFID and Cameras installed on the site (PRC Monitoring System) which help the project management team to fulfill their objectives, monitor and control the project more efficiently. On the other hand, Activities such as Information sharing, production tracking, progress measurement, resource management and safety control can be performed more efficiently by using an automated data collection method.

2.Literature Review

2.1.PDA

Present trend in the construction industry has necessitated the need for effective and efficient evaluation, monitoring and developing the physical progress reports. Manual monitoring of construction sites work is costly and error prone. There is also a risk to record the progress reports manually as to the human error being. In a messy construction site, it is hard and inconvenient for site supervisor or site engineer to carry bulky plans or reference to different parts of the site. Hence, by using software, construction site documentation can be simplified and made faster and overburdening of the site management is prevented by increased efficiency. Therefore, there is a need of Personal Digital Assistant (PDA) to run the software to enhance the productivity of jobsite management.

2.1.1. Application of P.D.A

2.1.1.1. The Application of PDA as Mobile Computing System on Construction Management

The Mobile Computing System is composed of two parts: the data input program in PDA and the output and analysis program in the spreadsheet application software of PC. The medium of the current system for the data transfer is a memory card. All of data related to the project such as drawing files, check lists, daily reports, specifications and list content files, is stored in a memory card attached to PDA (figure 1). The data generated by the operation on PDA is also stored in it. On the other hand, the different subsystems need to access the same information and share it effectively. It is useful especially in the application of computer-aided engineering for construction management due to many unique features and limitations. Users can make up the suitable workflow with the combination of formalized user interfaces as design pattern in this system. The input data with PDA are transferred to the system in PC and thereby Users can analyze them and make some graphical outputs easily and quickly (Kimoto *et al.*, 2005).



Figure 1: Data input and output with PDA

2.1.1.2 Automating Progress Measurement of Construction Projects

Many construction companies consider the measurement of work in progress to be one of the most challenging problems faced by project management team (Navon, 2005). In construction projects, site managers normally spend a significant amount of time for measuring, recording and analyzing the progress of work. This is essential for many business and project management functions such as cost and schedule control, financial reporting, claims and productivity measurement (Zhang, 2009). By using PDA and extracting diary data from it, we can collect required data for progress measurement and analyze it by inputting data to a pocket pc in order to facilitate project monitoring.

2.2.RFID

Accurate data collection has always been an important part of project control both in procurement and construction phases. The RFID enables precise data acquisition by tracking materials. This feature is very useful especially in the case of orders with long leads. This technology enables the detection and identification of tagged objects through the data it transmits.

RFID uses radio waves to identify people and objects. An RFID system consists of an RFID tag and an RFID reader. The RFID tag consists of a small microchip and an antenna. Data is stored in the tag, usually in the form of a unique serial number (Wang, 2007). The RFID reader acts as a transmitter/receiver. The reader transmits an electromagnetic field that “wakes-up” the tag and provides the power required for the tag to operate. The tag then transfers the data to the reader through the antenna. This data is then read by the RFID reader and transferred to the Pocket PC or computer. Unlike barcodes, RFID tags do not have to be line-of sight. They only have to be within the reader’s radio range.

This evolution in automated data acquisition has expedited the process of data collection and also brought a lot of advantages to construction industry.

2.2.1Applications of RFID

2.2.1.1. Procurement control

Supply chain is considered to be the flow of products, information and fund through the chain of organizations involved (Wang, 2007). Tracking the products from the initial stage (supplier) to the final phase (customer) seems to be a vital factor in a competent supply chain management (figure 2). By optimizing this process through the chain, RFID enables companies to reduce the cost and time of control and ensure persistent production.

2.2.1.2. Documentation

In a busy construction site where a lot of documents like RFIs, change orders, shop drawings, payment requests, etc are exchanged among parties, having a competent documentation system is crucial. By using RFID technology latest version of documents can be traced and found without wasting any time. All the essential information can be entered to the database and a unique tag can be assigned to the relevant data which makes it easier for the personnel to find the document.

2.2.1.3. Inventory forecasting

Inventory control is one of the major applications of RFID and has become widespread among construction companies as well (Tajima, 2007). By knowing the amount of materials available in the inventory and also knowing the consumption rate, managers can make better decisions for ordering, storing and also using materials.

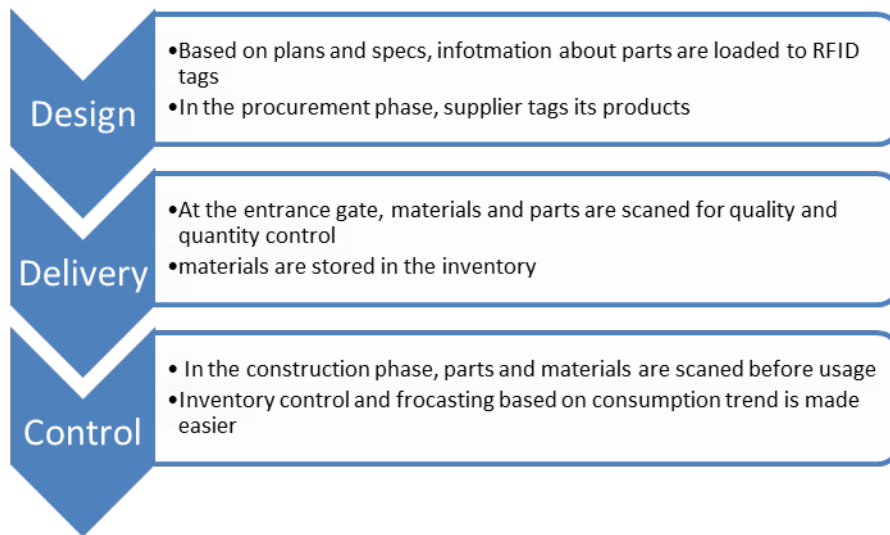


Figure 2: RFID Applications

2.3.Camera

Taking photos from job site and specially works that are going to be covered later is a common practice in construction sites to avoid disputes in the future. From the Managerial perspective, cameras can play an important role in controlling and observing job sites from headquarters. This method is especially useful when the location of the site is considerably far from the main office.

2.2.1 Applications of Camera

2.3.1.1. Communication and Documentation

Poor coordination and incompetency in documentation is one of the rampant problems among construction projects. Using photos, taken on standard intervals, enables project team members to prepare comprehensive reports for meetings and also helps the crew to minimize the number of visits to the job site. Making use of cameras also exempt site crews from documenting information down to the smallest detail such as weather condition, yielding more time to personnel (Deng, 2001).

2.3.1.2. Resource Management

Using cameras in monitoring resources such as work force, materials, inventories, equipments in site can reflect many imbalances in the project. Time wastage, task completion duration and inefficiencies can be recognized and then adjusted to optimize project resource allocation (Senior and Swanberg-me 1997). By observing camera's photos, inventories, manpower, materials and equipment can be quickly monitored and positioned.

2.3.1.3. Travel and Safety

Once jobsite is far away from the office, construction manager has to directly supervise the project. It would be costly and may jeopardize superintendant's safety. Using cameras not only minimizes project's expenses by reducing frequency of trips, fuel cost and wear and tear but also guarantees personal safety during the project. In addition, more protection against vandalism and theft can be provided by virtue of mounting a camera on site.

3. Proposed System

During the construction phase, diverse information is collected via PRC. These data are transferred to the local system where they can be processed for better use. As depicted in figure 3 visual data, procurement data and diary data constitute the main parts of the inputs in the system. Each party involved in the project has a level of access in accordance to their authority. Data collected in inconsistent manner is not as

useful for construction manager as that collected regularly and in a standard fashion. Its major application is monitoring progress of construction activities, especially from a distance and at a standardized view point. Visual data consists of all the images taken during the construction phase. In this part users can have access to the archive of daily photos and films. Images can be selected and inserted in diaries, generated by PDA, to demonstrate more details. Off site project managers can connect to the system and monitor the job site through high resolution cameras installed in different parts of the site and in case of any problems inform the superintendent by paging his PDA to take corrective actions.

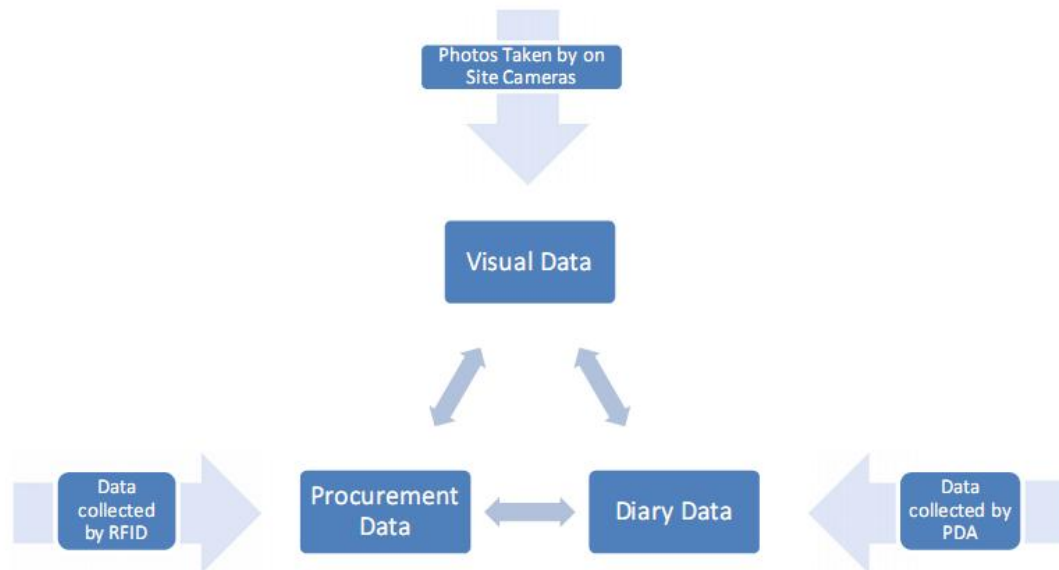


Figure 3: Data integration system in PRC

By integrating RFID tags into PDA, site engineers can be supported to capture data and work processes efficiently and productively in jobsite. As a result, a set of RFID-enabled PDA produces influential transportable device. Data collected by PDA is categorized into two main groups: checklist and daily reports. Daily report is the summary of all the jobs performed in the site, status of weather condition, gangs and labors, plants and equipments used. Checklists are the predefined forms in PDA that show the list of tasks to be completed within that particular day. All of these data are saved in the memory of the PDA and then transferred to the system. PDA can be updated through new plugins, forms and quality test forms that are available on the internet. PDA can be also used as a checklist for quality tests, so making decisions on components with defects is much easier and faster with plotted results. When the data is uploaded, parties can review or search the data to make a reference in case of any possible delays or claims. Furthermore, the extracted data also assists the project management team to evaluate the project progress and generate SV curve. RFID tags pasted to materials, equipments and plants aid the project team to determine the incoming and outgoing items in jobsite. It also helps them to track long lead materials to prevent delays. When new deliveries arrive to the jobsite, field engineers should check the quality and quantity of the components meanwhile making mistake in counting in big deliveries is unavoidable. PDA integrated with RFID is an effective tool to increase accuracy and expedite counting the deliveries.

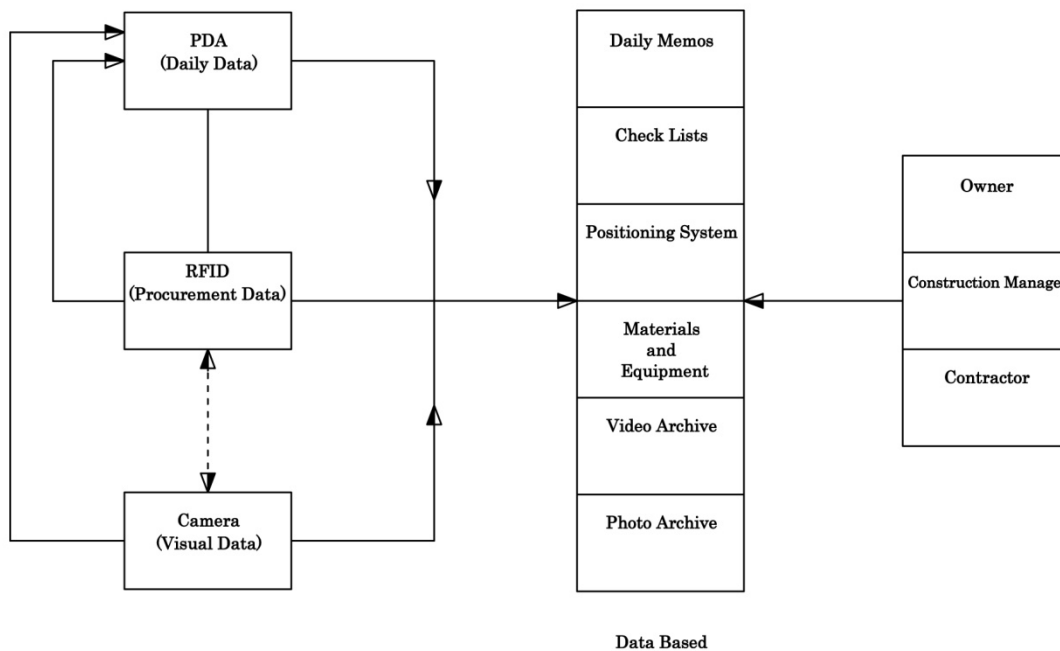


Figure 4: Proposed system Diagram

By using this technique not only suppliers can trace their products and their status but project managers can also check the inventory and implement a corrective action in case of any late delivery (figure 4).

4. Conclusion

Construction is one of the most information-dependent industries, mainly due to its extended fragmentation. Construction projects are often complex and unique, involve a large number of activities, and require the employment of several human resources with various specializations. Thus, the amount of information generated and exchanged during the construction process is enormous even for small-sized projects (Chassiakos, 2008).

The common document based data collection method applied in most construction firms is very slow and suffers from many deficiencies. Since the goal of project management team has always been the completion of project within appointed time and cost constraints, it is wise for contractors to surmount this pitfall by using more modern method. By introducing PRC data collection method, this paper proposes novel system in which new technologies such as PDA and camera are integrated with RFID to enhance project control and monitoring. Collected data from PDA, RFID and camera are transferred to a data base then processed, categorized and disseminated among parties.

Replacement of document based method by PRC data collection method can modify its numerous drawbacks. PRC uses technology to reduce routine tasks at construction site, facilitate ease of access to information, minimize daily commutes, increase security, improve inventory and resource management and lessen the bureaucracy significantly.

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