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W102 - INFORMATION AND KNOWLEDGE MANAGEMENT IN BUILDING

PAPERS AND POSTGRADUATE PAPERS FROM THE SPECIAL TRACK

Information is an all-pervading ingredient in building, common to research and practice. By giving proper consideration to the flow of information, research results can be usefully translated into innovation and further adapted to provide the knowledge-base for best practice. In an environment in which the tools for making information available are developing at breakneck speed, it is necessary to manage the whole spectrum of information forms in a way that reflects the realities of decision-making in modern building practice. In this context the objective for the Working Commission is to cover concerns that are related to information and knowledge management, both theoretical and practical. Special points of attention include interface between general information and the building process and especially the dysfunction in the flow of information between researchers and practitioners. The questions why research results are not put into practice, and how research results and feedback information can be converted and refined to be of practical use will be considered and contemporary information systems bearing on the information needs of the building industry.

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Information and Document Management System for Construction Sites

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Abstract

Each construction project is unique in terms of how specialist professionals manage and use project documents. A construction sites use and generate a large body of documents containing valuable information across project participants. Therefore, the efficient deployment of construction projects depends partly on the effective communication among project participants. This communication, however, is hindered by the large amount and wide variation of the project information and documents involved and the spatial dispersion of construction sites. This paper presents an intranet-based information and document management system that facilitates project information and communication management within a large construction company. The system implementation and testing have shown that it can provide structured and reliable information, quick and remote access, and prompt updating capabilities of stored documents.

Keywords: Communication, construction, documents, information, management

1. Introduction

Construction is an information driven industry. Construction firms all over the world are increasingly being challenged by high cost pressure, shortened project cycles and increasing competition. Within a business environment, where fast and reliable access to information is a key success factor, the efficient handling of project documents is crucial. Hicks (2007) underlies project information managed is of some value to the company individuals and that the information management system implemented support the flow of information value.

A construction company generates an enormous quantity of data that needs to be stored, retrieved, communicated and used by all parties involved. The amount of information that is created, stored and accessed within a construction organisation has risen exponentially and continues to rise (Dawood et al., 2002). This ever-increasing volume of information is driven by the variety, diversity and numbers of sources, tools and methods for generating information, which are themselves continually rising in number. Because of this increasing volume and diversity of information types (including information records, information sources, electronic files and electronic documents) dedicated systems are developed for archiving and accessing particular types of information (documents/files) including for example records and database management systems (RDBMS), document management systems (DMS) or content management systems (Curtis and Cobham, 2002).

New opportunities for collaboration, coordination and information exchange among organizations are being created by the use of communication and information technologies. The number of documents and actors in construction projects environment is quite large. The management of documents in physical support (paper support) has known disadvantages in areas such as security, productivity, economics and environment, in any industrial area. If there is no concern in centralizing the entering information or in creating functional ways to organize it for subsequently information research, the risk of not finding a document or its copy is increased. Sometimes, documents are destroyed because someone took it out of place for consulting and didn't replace it in a correct location. Documents are archived in central repository and are duplicated in department's archives, and sometimes in personnel archives.

A document is subject to many copies which imply costs in storage (support and space), copy (paper and ink) and environment. Documents in digital support or physical support normally flow between e-mail boxes or between desks, in sequent, recurrent and none controlled process. The duplication of the information, associated copies, decentralized information, thus, missing control have consequences in executions tasks' time and other issues, bringing no profits for the future.

This paper presents an intranet-based information and document management system that facilitates project information and communication management within a large construction company.

2. Methodology

The prerequisite for developing an information and document management solution in which project information can be shared and used to enable and improve construction processes is identifying the sources and nature of information and its flow from a particular source to a specific destination. Thus, the methodology is grounded in empirical modelling which, according to Beynon et al. (2002), "involves a paradigm shift in which experience becomes the primary and primitive ingredient." In order to understand the source flow of project information a qualitative case study approach was undertaken whereby various actors, knowledge retention practices, access and retrieval of knowledge and issues in sharing knowledge were identified and analyzed. The strength of the case study research method is its ability to perform in-depth investigations when the case under study is broad and complex and cannot be studied outside the context (Klein and Myers, 1999; Yin, 2003). Furthermore, this approach also allows the use of flexible ways of collecting qualitative data and aims at providing an internal information management solution validation during the course of the information and document management system development.

Data was collected in a series of personal interviews conducted with various groups, including managers and employees, within the project organization. Interviews collect field data for empirical modeling (Humphreys et al., 1996) in order to select relevant knowledge artifacts from the list of potential ones. Collecting data for empirical modeling requires creating a sample of project sites that represent the reality in the field of the study. Thus, the authors have studied three information-intensive construction project sites over an 8 month period.

On the basis of the literature reviews and workshop discussions, the authors developed a template for conducting case studies and writing case descriptions of selected construction project sites. Thus, workshop discussions and informal meetings were held at all three construction sites. They were aimed at defining the core variables of the case studies. In order to examine the information and document management effort and activities in the organisational context, this study was carried out in three stages. In the first stage, the data, from three case studies, was identified and collected. In the second stage, the information management processes and tools found in those cases were analysed and their key factors were investigated. In the last stage, the empirical findings and recommendations for the development of information and document management system were compiled for discussion.

To be able to evaluate the collected data, a checklist was created with all the documents found in the archives and all the documents listed in company's archive procedure. The checklist contains the location for every original and copied document according to every department in the company. Field data were processed and analysed by all of the authors in order to avoid discrepancies and individual biases. There is an agreement among interviewees that information and

communication technology (ICT) can help to improve information sharing, communication and interaction both within the project team and within the project delivery chain. Most interviewees agree that information managed is necessary and expect that an ICT based system has many advantages in enterprise asset management. However, the there case studies show that electronic mail and the Internet are the main ITC used in most construction sites.

3. Theoretical background

Information and communication technology is often associated with improved organizational flexibility, quicker access to information, fast responses to changing conditions, greater innovation and improved decision-making (Tseng, 2007; Meroño-Cerdan et al. 2008). They are deeply embedded in the existing organizational culture and workflow of construction firms. Technology is not only important to help individuals communicate and interact, but it is also a means to collect, store, retrieve and transfer information and knowledge (Tseng, 2007).

Loukis et al. (2008) stressed the effect of external environment related factors on the business value generated by ICT investment. They concluded that there are external conditions that result in higher business value from ICT investment. Chuang et al. (2009) studied the effect of compositions of managerial characteristics of the top management on the extent of ICT adoption in construction companies. Cockburn and Highsmith (2001) stress the role of good communication and interaction within a project team in the team members' commitment and performance. Therefore, it is worth improving both individual's competencies and collaborative skills. Modern ICT holds good prospects for improving the business processes of the construction industry, particularly in the field of business management (Curtis and Cobham, 2002; Benjaoran, 2008). ICT can help to enhance collaborative teamwork to provide cooperative network systems, available to all employees. Site project team members can share and reuse company's information. Project documentation should flow smoothly through the cooperative network system to allow document sharing by all project stakeholders. Palaneeswaran et al. (2005), emphasise the need of an effective information management along the project, since people move from one project another making very difficult to establish an effective communication network amongst site workers.

Several studies on information management have been developed to date. Rezgui et al. (1996) developed a management system that aims to increase the cooperative work in the building industry throughout the lifetime of every project. The system defines in a scheme all the processes involved in the project, including the responsibility taken by each one of the collaborators involved. The model considers the process of information propagation, notifying the users about every data change or update, as well as the effects of such changes. The model also includes a feature for data index and retrieval. Ameziane (2000) has conceived an information management system that includes databases shared through the Internet. Like the authors mentioned above, Ameziane stands for the cooperation amongst collaborators even if they work in different activities. He proposes a database for every project built, properly organized and divided in classes according to the nature of each project. The main role of this database would be to gather and retrieve all the relevant and updated information to the characters involved in the project. The automatic communication and information management

system developed by Dawood et al. (2002) also uses internet technology and it is formed by three key elements: Web Server, Client Server and User Interface. The link between the two servers is provided by the interface. Along their research, the authors came across two major issues: the many processes involved in a building project and the lack of a proper format and language used in information exchange. Caldas and Soibelman (2002) developed a document classification system in 6 stages: data selection; data preparation; data size reduction; definition of training and testing; Creation of Classification Models and document classification system. This system distinguishes from all the others in its conception and purpose. It was developed as an auxiliary tool to distinguish, classify and organize the different types of information. Another system by Caldas and Soibelman is based on building industry documents in text format, processed in three stages: classification, result retrieving and hierarchy and association (Caldas et al. 2002). A management system for information in geotechnical engineering was developed by Schley and Holtz (2005) based on two primary objectives: resource management on a construction site using Web technology; gathering and integrated information management from all these resources. Like Ameziane (2000) and Dawood et al. (2002) use Web tools in the model to accomplish their objectives. These authors analyzed all the processes evolving the building process and the information flows generated between all the collaborators in order to identify and extract the essential data. Like in Dawood's model, the database can be accessed by any user (such as the client) through an ordinary web browser with no need of any special software. Persson (2006) has recently developed another model for an information management system based on the pre-fabricated concrete structures industry. Like Dawood and Schley and Holtz did before, he studied all the industrial processes taking place in this specific industry as well as all the processes evolving data and ICT. A web based document management tool (WPMS – Web based Project Management System) was presented by Forcada et al. (2007). The authors claim that an effective document and data share is a primary need for the Spanish small and medium sized companies in the building industry. For them all the information should be stored in a main server accessible through an electronic document management system.

Each author mentioned above agrees that the construction industry generates great amounts of data, whether it is paper documents or electronic data, and this data needs proper management. The wide variety of formats and the nature of such data sustain the argument that such a management system with standard formats is quite necessary in order to improve communication amongst all project collaborators. Most of the models presented concur by using central data storage unit that retrieves updated information and keeps track of those updates, controlling the information that is made accessible to each user depending on its task and needs. Since there are so many different entities working together in the construction industry, it is also claimed by these authors that a common language should be established in order to make communicating and information share easier and more effective.

However, construction companies have historically not managed the transfer of project information well and have not effectively developed a project management learning culture that takes into account both technology and people. This may be due to the temporary and unique nature of the project and the typical release of project resources as a project approaches its completion.

4. The proposed system

Information management for projects should address concrete uses of construction sites. The case study action research helped the authors to develop an information and document management system adjusted to the nature of construction projects. Thus, a construction company was chosen as a model for developing the proposed system.

In Company's daily activity, a large amount of data is generated, sent and received, thus, creating complex information flows. Therefore, in context of this research project, a Web-base collaborative information and document management system was developed during 2008. This system was developed on Microsoft SharePoint Server 2007 application, and is aimed to: i) manage corporate and project documents; ii) store and transfer project feedback site information; and iii) transfer company procedures and best practices within the organisation and across project teams. This system is supported by the architecture shown in Figure 1.

The architecture shown in figure 1 consists of two Web-Front END, one Application Server/ Index/Search Server, one Database Server linked to a high speed Storage Area Network. Documents, images, files, documents' registers and other documents are stored in the database server. The database works as an information and knowledge repository, making information and knowledge available via WEB to the firm's project organisations and departments on a business-to-business basis through the existing network. The focus of the implemented information management system is on capturing, codifying and storing information and knowledge in a structured and collaborative manner and making them available through the Company's intranet. The system is developed and maintained in the Company's headquarters. It uses a centralised organisation. However, the system as it stands allows, via the intranet, two-way vertical communication within the group unit and collaborative teamwork. The proposed information management system has an information and communication technology (ICT) focus. Thus, Information sharing is emerging as a consequence of the ICT infrastructure. According to the project participants, it facilitates cross-functional communication and internal information search.