



A web-based system for managing construction information

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ABSTRACT

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 information involved and the spatial dispersion of construction sites. This paper presents a web-based system that facilitates construction information management and communication. Unlike common document-based systems, the present work focuses on demonstrating the potential of data-centric web databases in enhancing the communication process during project execution. Further, this work has aimed to put emphasis on information modelling, i.e., representation of the construction process in data to facilitate exchange and interoperability of information. The proposed system consists of a relational database and a dynamic data-driven web application. The database contains 32 appropriately designed tables. End users access the database through the internet and can perform certain transactions according to their authorisation. The system implementation and testing have shown that it can provide structured and reliable information, quick and remote access, and prompt updating capabilities.

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1. Introduction

The development of construction projects includes several stages during which a large number of human resources of different specialties interact and cooperate for performing the various project tasks. An important element in this interaction is the information management and communication process which constitutes a determinant factor for the efficiency of human resource cooperation. Thamhain and Wileman [1] stated that communicating effectively among task groups is the third most important factor for the success of a project, while Egan [2] concluded that more efficient information management is a primary mechanism for the construction industry to increase its productivity. Enhancing communication among project participants, however, proves to be a challenging task due to the extended fragmentation of the construction industry and the huge amount and wide dissimilarity of the information that is involved in the construction process. The wide variation of specialties, expertise, educational background, professional skills, computer acquaintance, and working environment among the project participants impedes the information management and communication of the project team. The distance between the construction company headquarters and the (often remote) construction sites renders the communication even harder. The information volumes and types associated with construction projects are such to make information management a

difficult task while the uniqueness of civil engineering projects makes arduous the effort for information standardisation. Effective information communication requires the existence of structured and reliable information. As construction projects become larger and more complex, an efficient way to provide such information is through the use of information management systems.

In order to surmount current information management and communication deficiencies, more emphasis should be given to information technology tools. Database and internet technologies provide substantial capabilities in this direction. Database management systems are nowadays powerful and allow sophisticated manipulation of vast volumes of information. The internet and the WWW are attractive for transferring information rapidly and economically all around the globe with no regional or temporal borders. These technologies provide, thus, a suitable platform on which organised attempts to manage and share construction information could be fruitful. This paper presents an attempt to improve the efficiency of current information management and sharing practices by combining database and internet technologies, and placing a special emphasis on information modelling. Modelling construction information can be thought as the representation of the construction process in data to facilitate exchange and interoperability of information. A system is presented that consists of a repository database and a web application. The database is populated along the use of the system with construction information while the project participants can interact with it through the web. The objective of the research is not to provide an off-the-self commercial product but, rather, to experiment on

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the development, implementation, and efficiency of such a system. The paper is an updated and revised version of the conference paper [3].

2. Previous research

A number of research efforts have dealt with the information management needs of the construction industry and the use of information and communication technology (ICT) for improving the efficiency of the construction process. Atkin [4] discussed some information management problems in construction and existing solutions. Chassiakos [5] presented the key elements of the information management process in construction and discussed the use of computers for information management and communication. In general, research efforts that relate to information and communication technology applications in construction can be classified as follows:

- Conceptual frameworks of web databases.
- Electronic document management (EDM) systems.
- Information analysis in construction.
- Web-based applications in construction management.
- Reviews and case studies.
- Application service providers (ASP).
- Construction information standardisation.

The development of information management systems that combine database and web technologies is considered significantly beneficial for the communication process. Conceptual frameworks of such systems have been presented and discussed in Garcia et al. [6], Abudayyeh [7], and He [8]. Tam [9] and Deng et al. [10] proposed the development of an internet-based system that comprises six major functions including data exchange, emailing information exchange, internet chat, live video-cam, search engine, and auxiliary services. Such efforts, however, have been mostly directed to data transfer applications and less to information modelling.

Electronic document management systems (EDMs) have been developed to track and store electronic documents, providing storage, versioning, metadata, security, as well as indexing and retrieval capabilities. An early research effort on EDMs is presented by Bjork et al. [11] who provided the functional description of an integrated construction project document management system. The approach adopted concentrates on the management of documents in digital form and not on the management of the information within documents or databases. Finch et al. [12] proposed a method of bar coding hard copy drawings in order to electronically transfer secondary document information from designer to contractor. Rezgui and Debras [13] aimed to demonstrate the computer-aided generation of project documents via a construction project data model, in which hypertext references enable navigation from one documentary item to another, internal or external to the document. Hayes et al. [14] described the state of the art in EDM systems for the construction industry and, among others, three EDM systems used in the European Esprit Condor project. Hajjar and AbouRizk [15] presented an integrated approach for an electronic document management system, based on the concept of specialized construction data models. The relationship between a document and certain aspects of the constructed facility and the construction company are explicitly represented. Björk [16] presented a set of research questions and methods that can be used in order to make observations on the research knowledge about the introduction of EDM systems in the construction industry and clearly articulate these questions, helping in the definition of an agenda of research needs for the near future.

Systems that involve databases require a thorough analysis of the information that is generated and exchanged throughout the construction process. In this direction, Froese et al. [17] described the conceptual stage of computer tools that support construction management and provided a partial listing of project documents and functional categories for project management. Shahid and Froese [18] studied project information and information flows in construction, mapping various types of information against the documents that typically provide the information and the construction management functions that provide and access the information. The above information analysis efforts, although necessary for developing construction information management systems, have not led to the development of information management applications in response to practical needs of the construction industry.

Regarding web-based applications in construction management, Faraj et al. [19] proposed an IFC-based collaborative computer environment that enables the communication of distributed applications such as design, visualisation, estimating, planning, specifications, and supplier information. Abudayyeh et al. [20] designed and implemented an intranet-based cost control system that allows the automated production of specific cost reports. Dawood et al. [21] designed an internet-based information management system for commercial retail buildings, focusing mainly on drawing management. Mokhtar [22] developed an intranet-based information model for facing the problem of incompatibility errors in drawings. Chan and Leung [23] presented a conceptual model of a metadata-based information system for data exchange among web-based documents for construction project management. Cheung et al. [24] developed a web-based performance monitoring system that includes performance indicators in the categories of People, Cost, Time, Quality, Safety and Health, Environment, Client Satisfaction, and Communication. Zhiliang et al. [25] summarized the characteristics of the exchanged information in construction projects in China based on the literature survey and field investigation, and proposed a web-based approach for developing a system for the management of exchanged information in construction projects using XML. The scope of these efforts is to meet specific needs of the construction sector rather than to experiment with the development of a system whose objective would be the management of information.

A number of papers have also reviewed several aspects (requirements, advantages, drawbacks, development difficulties, etc.) of the conceptual framework and the development of the internet-based information management systems while others reviewed certain case studies. Such discussions and reviews can be found in Opfer [26], Weippert et al. [27], Andresen et al. [28], Lee et al. [29], and Magub and Kajewski [30].

With the boom of the internet, a number of professional information technology companies developed commercial web-based systems for the Architectural, Engineering, and Construction (AEC) industry. These systems are either leased as services by the so-called Application Service Providers (ASP) or sold as web-enabled software that is maintained then by the construction company itself. Such systems include Buzzsaw by AutoDesk [31], ProjectWise by Bentley [32], BuildingCenter by Briscnet [33], Information Channel by Building Information Warehouse (BIW) [34], Teamflow by CFM [35], Citadon [36], Constructware [37], eRoom by Documentum [38], e-Builder Enterprise by e-Builder [39], Iron-Spire [40], ProjectTalk by Meridian Project Systems [41], Prime-Contract by Primavera [42], etc.

The lack of data standardisation has been a major obstacle for computer-integrated construction research projects. The recognition of this problem has led to the ongoing development of such standards. The prominent efforts for the standardization of product models are the STEP (Standard for the Exchange of Product model

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