

An Electronic Document Management System for Public Construction Projects

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Abstract

This paper presents the development of an electronic document management (EDM) system for public construction projects. The objective of this research is to develop a prototype system that will be able to automatically produce official documents needed during the development of such projects. The proposed system consists of a database and a user interface module. Two types of information are stored in the database. The first refers to document forms that have been developed in MS-Word format and are used as templates including text or other information that is common to all projects. The second part includes project specific information such as specifications, budget, contractor information, etc. This part has been structured on MS-Access and information related to a number of projects has been stored in it. After a user query for a specific project, data automatically fill in the corresponding template forms and the desired documents are developed. The employment of such a system is expected to enable prompt preparation of reliable documents. As a result, errors will be minimized or eliminated and the project development process will be expedited resulting in time and cost savings.

Keywords

Electronic Document Management, Public Projects, Construction Documents, Document Forms, Query

1. Introduction

The construction of civil engineering projects involves several development stages such as conception, design, planning, contracting, construction, handover, etc. Most phases require the cooperation of a large number of human resources. In order that the project is smoothly accomplished, there is a need for enhanced communication among all project participants. This can be achieved through the use of concise and reliable

information. Documents still remain the most common and widespread information-carrier in the construction industry. Consequently, the effective management of construction documents is a critical issue. This has led to the development of various Electronic Document Management (EDM) systems, which attempt to manage documents in a more efficient way than current practices.

Public infrastructure projects are typically larger and more complex than usual construction projects of the private sector. In addition, they involve bureaucratic procedures that can significantly delay the project completion. This paper presents an EDM system that facilitates these procedures by enabling automatic production of official documents that are transferred between the contractor and the public body (project owner). The objective of the research at this point is not to provide an off-the-self commercial product but, rather, to investigate the development difficulties and the efficiency of such a system.

In the following section, the EDM term is analyzed and previous research efforts related to it are presented. The proposed EDM system for public construction projects is then described. Finally, the expected benefits of the system are analyzed and the main conclusions of the research are reported.

2. Background

The term EDM has a vague meaning and, as a result, no exact definition can be found in the literature. There are three major perspectives in which the EDM term is commonly perceived (and further used) by researchers:

- A *document management approach* tries to manage existing and ready to use documents. A typical approach of this kind is the one that defines and stores documents, indexes them by single or multiple content, and supports retrieval by index. Documents are not necessarily in electronic format; they can also be shelved hard copies.
- A *model-based approach* aims to generate or retrieve documents through data models. A usual case of this approach is the automatic production of documents through a query. This is allowed by selecting the desirable pieces of information to be contained in a document.
- An *information management approach* attempts to organize and handle all information circulated in the construction process in an integrated and effective way.

Very few research efforts can be found in the literature for the first two approaches. On the contrary, much work can be found for the third one, which represents a much wider research field. The use of the term EDM in the third approach may be inapt and derives from the fact that the words “document” and “information” are treated as synonyms. This occurs because most of the information in the construction industry is contained in documents. Recently, due to the evolution of internet and web technologies, all the above approaches attempt to incorporate electronic document transfer.

Among document management approaches, an early research effort is presented by Bjork et al. (1993). It consists of 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. Later, Finch et al. (1996) proposed a method of bar coding hard copy drawings in order to electronically transfer secondary document information from designer to contractor.

Within the model-based approaches, the work of Rezgui and Debras (1996) aimed to provide pragmatic solutions to the problems of integrity and consistency of document-based information, by describing the development of a building through its lifecycle. The research demonstrates the computer-aided generation of project documents via a construction project data model. The researchers generate and implement hypertext references that enable navigation from one documentary item to another, internal or external to the document. Hayes et al. (1998) 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 et al. (2000) 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. Song et al. (2002) explored the feasibility of web technology as a means for delivering building information to better support facility operations and proposed just-in-time facility documentation as pragmatic solution to the limitations of current as-built documents, in an attempt to allow effective reuse of building information.

Finally, within the information management approach, Shahid et al. (1998) mapped various types of project information against documents that typically include the information and the construction management functions that provide and access the information. From this analysis, a computer system was conceptually designed to support the task of project information management. Bjork (2002) 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. The aim of the paper is rather to clearly articulate these questions and thus to help in the definition of an agenda of research needs for the near future.

Concluding this section, one can say that EDM research efforts aim to reduce document or information management needs. The information management approach seems to be fruitful in the long-term but benefits cannot be expected shortly since development requirements and difficulties prohibit its widespread adoption. Therefore, there is a need for more pragmatic solutions with enhanced efficiency potential, such as the model-based approaches. Although some research has been done on this field, it is mainly oriented towards particular sectors of the construction industry (e.g., structural steel fabrication and erection industry, Hajjar et al, 2000) or particular applications (e.g., facility management, Song et al, 2002). Moreover, most research efforts focus on the construction process but not on other phases of the project life cycle (e.g., tendering and contracting phase). It is hence clear that a wide area of future research is still available.

3. The Proposed System

An EDM system has been developed for electronically generating the required official documents associated with the tendering and construction of public projects. The proposed system can be considered as a model-based approach and its employment is expected to facilitate the document exchange process among the project owner (public bodies), contractors (construction companies), and other project participants. The system further could constitute a module of an integrated information management system for construction projects.

3.1 Project Phases and Documents

The development of the system has been based on current practices followed by municipalities and other public bodies in Greece. The process that a public body currently follows for the development of an infrastructure project was initially investigated. This process is common for the majority of public projects. First, a public body (municipality, prefecture, ministry, etc.) recognizes the need for a new infrastructure

project. The necessary funds are then sought for the design and construction of the project. In the case of small, ordinary infrastructure projects, the public body itself designs the project. The public invitation for bidding is published in the press and the contractor is selected among the candidates in accordance with the regulations and legislation. The selected contractor and the public body sign jointly the appropriate contract, and the contractor commences the construction of the project. The contractor is obliged to conform to project schedule and all other terms described in the contract. If no project alterations are required, the construction of the project is ended by its commissioning and handover.

At a second stage, the official documents that circulate between the contractor and the various representatives of public bodies were sequestered. These documents concern the whole process that was briefly presented above. For example, one of these official documents is the *auctioning approval*. Every public body that wishes to auction the construction of an infrastructure project usually requires permission from the regional administration. When replying positively, the regional administration sends the document *auctioning approval* to the public body, which can now proceed to the announcement of the auction and the auction itself. Fifty-two documents have been identified within the whole process and related information has been inserted in the database.

3.2 System Description and Application

The proposed system consists of a database and a user interface module. There are two types of information that are stored in the database. The first refers to document forms that correspond to fifty-two documents. Each of these documents has a specific format. The document forms act as templates including only “static” information (e.g., text) with no reference to specific projects and have been developed in MS-Word format.

The second part of the database includes project specific information such as project specifications, budget, candidate contractor information, supervisors, bill of quantities, funding, etc. This part has been developed on MS-Access, which enables prompt coding and retrieval of information of this kind. The user can insert project-related information to the system by filling in about 450 pieces of information (cells) organized in twenty-two tables created in the MS-Access environment. A list of these tables can be seen in Figure 1. Some

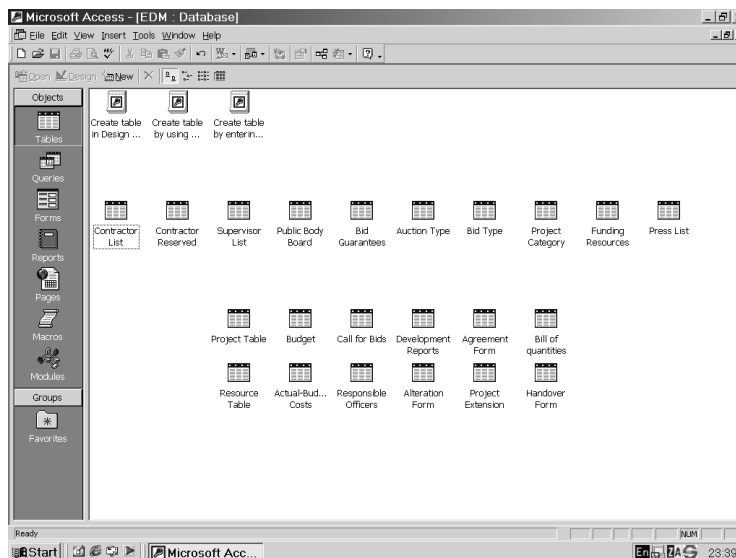
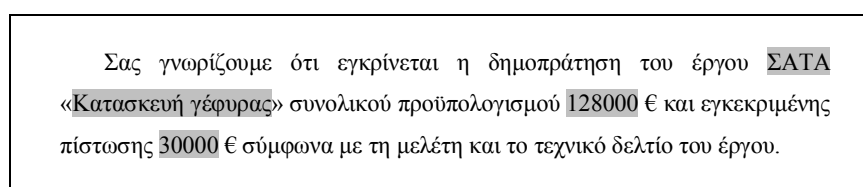


Figure 1: Tables of the EDM system

of the columns/cells of these tables require from the user to select among appropriate preset options. For instance, in “project category” the user can choose “structural”, “transportation”, “hydraulics”, etc. Other columns/cells are freely filled (e.g., project name).

The procedure to information retrieval and document development is facilitated by performing a query through the user interface module. The user can search for a specific project by selecting the corresponding index. If the project index is not known, it can be located in the database using other types of project information (e.g. project name, contractor, date, etc). The template forms are linked to the database and data automatically fill in the appropriate text fields of the template forms and the desired documents are generated. Figure 2 presents an excerpt of a document (*auctioning approval*) produced by the system (in Greek). The shadowed text (shadows are not printed in the final document) corresponds to the data that automatically fill in the document forms. The automatic production of documents is the main function of the system, but the developed database can also serve information classification and retrieval. For example, information for projects that have been assigned to a specific contractor, fall within specific budget limits or were assigned during a specified period, as well as contractor information and other structured data can be retrieved.



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Figure 2: Excerpt of a document as produced by the system

The system has been used for the production of all public documents for two projects. The projects involve the construction of a bridge and a port extension. All fifty-two official documents have been smoothly, effortlessly, and rapidly produced by the system, containing no errors. No problems have been identified during these two applications.

4. Benefits / Limitations of the System

The employment of the proposed system is expected to enable easy and prompt generation of reliable construction documents. Consequently, consistent and accurate information will be provided and document formats according to protocols and specifications will be developed. As a result, errors will be reduced or eliminated and the need for document reproduction will be minimized. Overall, the project development process will be expedited resulting also in cost savings for all parts involved.

An additional advantage of the proposed system is the fact that it has copied the current practice in public project construction and this augments its applicability. The construction industry is rather rigid and conservative and any innovation proposal that deviates from current practices may not be easily adopted. The proposed system is simple to use and does not require specialized personnel training (besides some knowledge of widespread office software tools). Moreover, the system constitutes a pragmatic and ready to use solution towards reducing document management needs. The system can also support electronic submission of documents through the internet.

On the other hand, some limitations or problems may arise. In particular, a few official documents that are needed in some cases may have not been inserted in the database. Also, the system does not include

documents that do not have a standard format and/or include too specific information to be incorporated in a structured document form (e.g., documents with analytical budgeted and actual expenses). Furthermore, the database filling with project-specific information may prove arduous in some cases.

5. Conclusions

In this paper, an electronic document management system for public construction projects has been presented. The proposed system is a model-based approach and allows the automatic production of official documents circulated among the project owner, the contractor, and other participants during the development of such projects. The proposed system consists of a database and a user interface module. The database includes fifty-two electronic document forms-templates developed in MS-Word format and containing text and information that remain unchanged from project to project as well as project-specific data for a number of public construction projects structured within the MS-Access environment. Through the user interface module the user can submit a query for a specific project and request generation of the desired documents, which is done by the program by filling in the appropriate project information into the corresponding document templates. The developed database can also be used for data processing and retrieval. The employment of such a system can improve document generation and exchange procedures resulting in project time and cost savings.

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