A SOCIAL NETWORKING-BASED APPROACH TO INFORMATION MANAGEMENT IN CONSTRUCTION

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***ABSTRACT*:** Construction projects require the exchange of large amounts of information between disparate actors. In order to solve this information management problem, previous research works proposed the use of Web-based databases as a means to increase collaboration and achieve efficient information management. However, they failed to acknowledge the existence of Web-based social network communities (SNC), which may provide valuable tools and features for information management. This paper proposes that existing Web-based SNC be studied to identify how the SNC paradigm and features may be adopted in the construction industry for developing information management systems. The use of Web-based technology for increased accessibility and multimedia organization tools like tags and grouping provide important means for identifying and classifying project information and associating it with its real-world status. Two social network models, project-focused and industry-focused, may allow for greater collaboration by the sharing of information in a common forum. However, the needs of the construction industry should be carefully considered before attempting to apply the social networking paradigm.

KEYWORDS: information management, social networking, construction industry, Web-based technology

1. INTRODUCTION

Successful project completion in the construction industry requires careful and timely management of information exchange between a wide variety of disparate individuals and parties. Difficulties in exchanging project information may result in project delays and legal or financial repercussions. Effective information management is critical due to the unique nature of construction projects; every project consists of a unique specification and different actors. Furthermore, once a project is complete, the information developed over the course of that project needs to be organized and stored in such a way that others can utilize the experience and knowledge gained.

Research has been conducted to understand both how and why innovative information technology (IT) solutions are adopted. Mitropoulos and Tatum (2000) identified four factors for the adoption of new information technologies among contractors: institutional requirements, problem processes, competitive advantage, and technological opportunity. Chinowsky and Meredith (2000) found that construction firms improved strategic management by encouraging employees to exchange knowledge and identifying potential opportunities to expand their market. Interviews conducted by Toole (2003) supported the competitive advantage and technological opportunity drivers as proposed by Mitropoulos and Tatum, but concluded that, while

construction contractors are applying IT solutions for information and knowledge transfer, IT was not being utilized for market and service expansion.

Furthermore, Toole made two important findings when surveying ten large construction contractors. First, contractors expect Web-based technology for collaboration between actors in a project to significantly impact the construction industry, but that there will be resistance to such integrated IT solutions. Second, the usefulness of mobile computing devices for the capture, storage, and transfer of project information over wireless networks will increase immensely, but the ability of firms to utilize these technologies is uncertain.

The continuing development of the Internet and the World Wide Web (WWW) has led to research on the utilization of Web-based technologies for the construction industry. Communication and information management systems for improving collaboration, utilizing high-speed Web access; Internet tools like HTML, Java, scripting, FTP, and so forth; standardized data formats; and the increasing availability of wireless access and devices, have been proposed by researchers in the construction engineering and management fields (Rojas and Songer, 1999; Dawood, Akinsola, Hobbs, 2002; Lee et al., 2003; Ariöz et al., 2007). These research works will be discussed in further detail in Section 2. However, they all propose a Web-based system for managing project information and/or uniting different project actors in a social network.

While these research works are technically sound, what they fail to address is that a Web-based system for the organization and exchange of information between people already exists. Web-based social network communities (SNC) have grown significantly in popularity over the last few years. MySpace (www.myspace.com), Facebook (www.facebook.com), Hi5 (www.hi5.com), Friendster (www.friendster.com), Orkut (www.orkut.com), and Bebo (www.bebo.com) are examples of popular SNC, with a world-wide distribution of users (comScore, 2007). These SNC function by providing a Web-based community for people who share interests and activities, and allow them to interact using common interfaces such as chat, messaging, email, and blogging; and the exchange of information by sharing files such as music, photos, videos, and so forth.

1.1 Objectives

This paper proposes the study of existing Web-based SNC in order to understand how this paradigm may be utilized for the development of information management systems in the construction industry. Understanding the technology behind these SNC is not as important as identifying how the construction industry can take advantage of the SNC paradigm. Many features of SNC may be useful for the construction industry, and could be transferred directly, whereas some topics may require careful consideration of the construction industry's needs before being adapted.

2. PREVIOUS RESEARCH

Four previous research works were identified as utilizing a Web-based approach for the management of project information or for establishing a social network for increasing information exchange and collaboration in the construction industry.

2.1 Rojas and Songer

The use of Web-based technology for building a new method of collaborative engineering was proposed by Rojas and Songer (1999). Their studied focused on the automation of work flow by utilizing Web

tools so that users of the system would not need high computer literacy in order to operate the system. In order to measure the advantages a Web-based system could offer, they performed a case study by comparing the traditional, paper-based inspection system with a prototype Web-based system. Their system combined software development, business process engineering, and workflow automation.

When comparing the paper-based and Web-based systems, Rojas and Songer found there was a significant decrease in information processing costs associated with automating and digitizing the inspection results; this cost savings was balanced by the computer equipment expenses, resulting in a slightly lower total cost (per square foot) for the Web-based system. Mistakes were reduced in the Web-based system, which was attributed to the strict information processing procedure reducing human error. Service, defined as “the ability to produce useful information in a timely manner,” was also better for the Web-based system due to the ability of the digital database to produce any report instantaneously, any time of the day. However, while superior behavior for the Web-based system was shown in the case study, the authors identified some concerns with utilizing a Web-based system: technology integration, adoption of the system by companies, and information security.

2.2 Dawood et al.

Dawood et al. (2002) proposed the development of an information management system for improving the coordination, distribution, storage, and access of project information. This research focused on communication of project information on-site during the construction phase of a project, defining two key issues: understanding project production processes and the lack of a formal information and data sharing system. The authors investigated these issues by a process requirement analysis and modeling and system development.

The developed system stored project files, which were available at any time for viewing, printing, or modification. Changes made to project specifications were immediately available to all project members, resulting in a large time savings. It also reduced costs by eliminating the need to produce paper copies of drawings. Overall, the system was found to provide time and costs savings relative to the traditional exchange of paper documents. It was concluded that optimizing the potential of IT resources may produce improvements in the construction process.

2.3 Lee et al.

A Web-based model for the exchange of electronic information was proposed by Lee et al. (2003). They theorized that IT development and the increase in number of Web users may allow for the utilization of Web-based technologies for increasing collaboration among actors in a construction project. This model was developed in three phases: study of construction documents work flow; analysis of existing electronic data interchange (EDI) models utilized in construction projects; and the proposal of a Web-based EDI model based on the results of the previous two phases. Extensible markup language (XML), a Web-standard document form, was used for the standardization of information exchange.

The authors found that construction work documents should not only be classified by work scope, but also by the dimensions of the document itself, such as frequency of interchange, volume of information, and degree of formalization. Using these dimensions, the applicability of the XML/EDI model to each document could be examined, and the authors concluded that XML/EDI was appropriate

for documents with few figures, high degree of text description, low volume, and high reference frequency. The use of a central database was then proposed as a Web-based XML/EDI model for managing users, document format and version, and information flow. The distribution of documents is controlled by programmed processes; user details, such as authority, personal history, and so forth are all contained in the user database; any changes to the document database are sent to the users via the management module in the system. This system was designed to be run by a single company, such as the general contractor, who manages the construction project information and distributes it to the other project actors.

2.4 Ariöz et al.

Ariöz et al. (2007) applied Web-based technology to the monitoring of concrete quality in the ready mixed concrete (RMC) industry. When using concrete in a construction project, the manufacturer provides the mix design, production, and transportation; the customer is responsible for placing and curing. The system developed by the authors attempted to connect these two separate groups by checking the properties at different stages of the mixing and casting process and providing this information to the pertinent actors.

This system primarily serves to improve the customer-manufacturer relationship. Customers can place orders online; once received, the system checks the concrete characteristics against the manufacturer specifications to ensure that the supplied material meets the customer's needs. Transportation data for the concrete is entered by both the manufacturer and customer, as well as concrete properties measured at the appropriate times. The system is also designed to provide a warning if any results fail to meet required standard values. Furthermore, mixing trucks can be tracked using general packet radio service (GPRS), and concrete properties during transportation can also be monitored and changes made to the truck's schedule as necessary based on the concrete quality. By utilizing a Web-based database for managing and updating the material properties, the quality can be monitored and controlled. The authors concluded that this system may reduce costs by controlling the product from order to delivery, as well as allowing the customer immediate access to all mix information via an Internet connection.

2.5 Previous research summary

The four research works summarized here all utilized a Web-based approach in order to standardize and simplify the means for exchanging project information. By using a central computer database, data processes could be automated for reducing errors and increasing quality, and project information and documents could be made available for access to all project actors at any time, thus reducing delays and increasing cost savings.

3. SNC FEATURES

A social network is a structure composed of nodes connected to other nodes by some relationship or interdependency. Typically, these nodes represent individuals or groups of individuals, and the relationship is some value such as interest, friendship, financial transaction, etc. Web-based social networks have grown around allowing a user to upload their information to a profile. Then, the user can establish ties to other users in the network based upon whatever social connection exists between them. In some cases, the two users may share a common interest, thus creating a tie between the two nodes.

Social networks may take a large variety of

forms, from the very simple (personal address book) to the sophisticated (Web-based SNC). They may also be for casual (again, Web-based SNC) or business (job hunting sites) use. In this paper, Web-based social networks were chosen due to the rapid growth and popularity which they have seen in recent years. Three categories of features will be presented: Web-based technology, information organization and exchange, and user control.

3.1 Web-based technology

The growth of the Web and the Internet has allowed for the ability to access data and make contacts instantaneously by utilizing the perpetual connectivity of the Web. Social networks have capitalized on this accessibility by providing an interactive structure in which users can provide up-to-the-minute information and distribute that information instantaneously to their friends and contacts. Furthermore, Web accessibility is growing as wireless networks and devices (such as next-generation cellular phones) increase in number and sophistication. This in turn allows even more up-to-date information exchange, as the number of locations and means by which users can access the social network increases.

Social network providers cannot control the end-user; therefore, they have to ensure that the interface they provide is usable by anyone. Web scripting and programming languages, such as HTML and Java, are two ways which have been established as a common means for accessing Web content. Ideally, Internet browsers are programmed to understand these languages without requiring any special software or download. Accessibility without complicated requirements is important for providing access to a large number of people with a wide diversity of abilities. Therefore, a simple, common interface, such as that provided by the Web, is important when dealing with a user base of unknown capability.

The importance of Web-based technology for assuring accessibility of information in the construction industry has already been discussed in the surveyed research works. However, it's important to mention that using the standardized interface of the modern Web browser decreases the difficulty of integrating other companies into a social networking system.

3.2 Information organization & exchange

Users in SNC often share photos or videos between each other. In order to identify the contents of these media, tags are applied by the user. Tags are similar to keywords, in that they allow for the classification and organization of media without surveying the entire content of that media. These tags are, however, not limited just to categories or contents. People in videos or photos can be tagged by their name and have that tag connected to their user profile. This allows users who view the photos to make connections to other users. The information provided by users in their profile can also be viewed as a type of tagging. Data given in categories such as 'education,' 'interests,' 'activities,' and so forth provide information which can be used to organize and classify the users themselves.

Media can also be categorized or tagged by event. An event may be similar to a user profile, and represents some gathering of users, either in the real or digital world. In this case, the tie between users is the mutual attendance of the event. Event information, such as time and location, as well as media can be uploaded and tied to the event.

Applying tags to media allows for the organization or grouping of different forms of media

based on a given search topic or selection. In social networks, grouping is a basic way of finding other users who share similar characteristics, or gathering disparate types of media together based on a single common theme. As mentioned previously, media can be organized by date or time as well; this adds another dimension to media organization.

For the construction industry, being able to quickly and efficiently organize users, media, and so forth, based on temporal, geographic, content, or other dimensional specifications would be beneficial for managing information in a construction project. By utilizing online computer databases for storing users, media, and their attached metadata, the ability to organize and group would be limited only by storage space and processing power. Furthermore, as mentioned in Rojas and Songer, computer-managed databases can organize and disseminate information faster, more efficiently, and with fewer errors than a human-managed system.

3.3 User control

The ways in which SNC have given control to the network users has been, in part, driven by the need to ensure privacy. Social network users provide personal information, but they may not want that information available to everybody on the network. Hence the development of privacy controls, which allow users the power to approve who sees their information, as well as how much information is viewable. Information control, with relation to the construction industry paradigm, will be discussed further in Section 4.1.

3.4 Example utilizing SNC features

A simple, conceptual social network model for a construction project was built using the information organization and exchange features in Section 3.2. This model, shown in Figure 1, assumes the construction “project” as the core feature. Within the project, there are several sub-categories: project information, users, media, events, and updates.

Details about the project are given in the “information” sub-category. General information about the project, such as location, description, and scope, is stored here. Since “information” is a sub-category of “project,” any information stored here is directly related to the project.

The participating project members are given in the “users” sub-category. In this group, the different roles of the project can be filled by users, such as owner, architect, or inspector. Each of these users then has a “user profile,” which is used to provide information about that user. The “activity” sub-category is used to track any actions of the user; if the user is identified in another set of data, then that information will be related back to the user’s profile. The “employment” sub-category is like a digital business card stored in the social network.

The “media” sub-category is the storage space for all digital files related to the project. Media uploaded to the project is accompanied by identifying metadata, such as the uploading user, tags (or keywords), a brief description of the media contents, the event to which the media relates, and so forth. Once this information is stored in the database, the media can be related back to the user and/or event.

The “event” sub-category is a virtual calendar which stores information about project events. The timeline is a master calendar which holds all the dates and their related events; each event has its own related information such as date, location, description, related media, and attending users. After an event has occurred, data can be uploaded into the

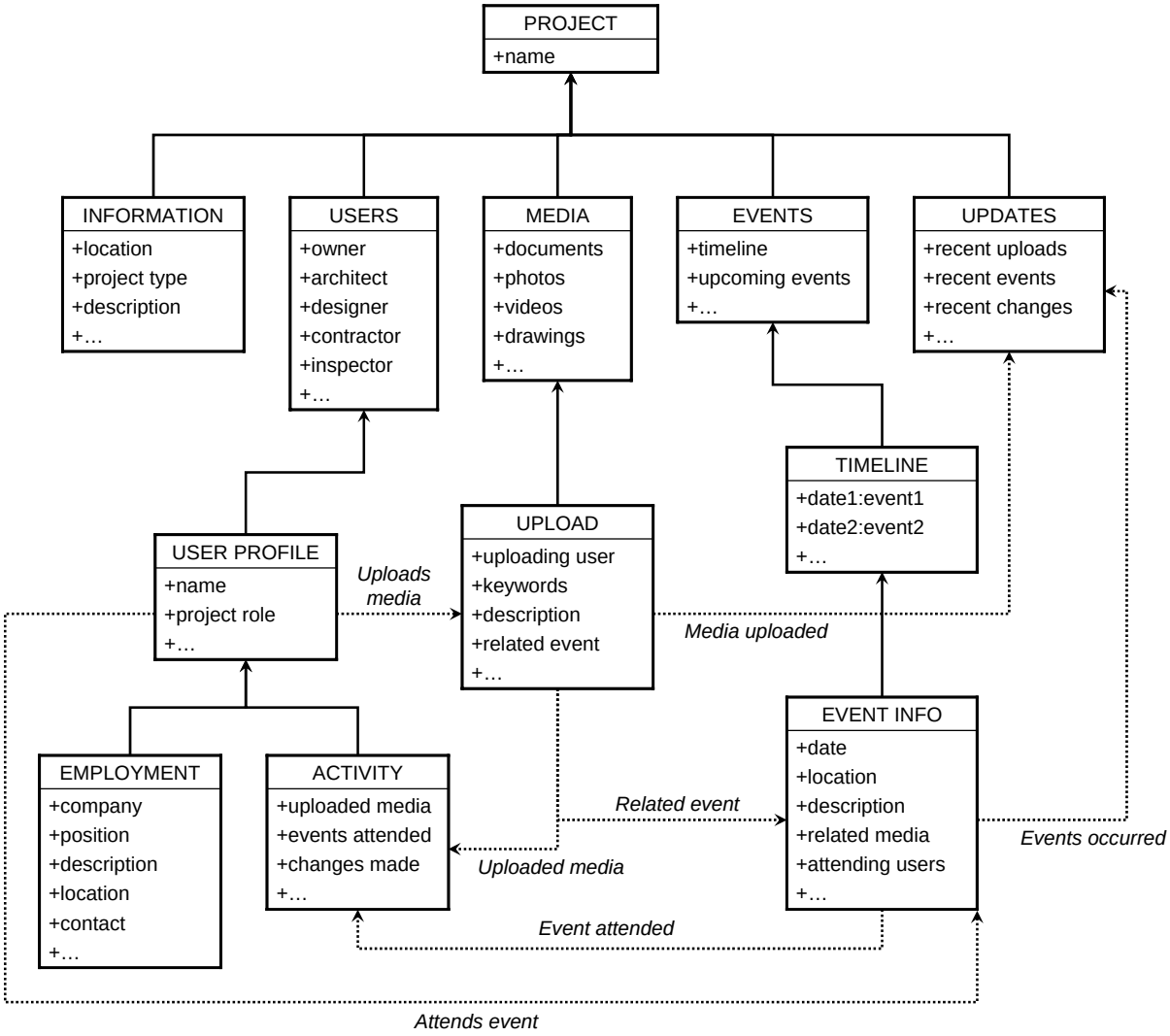

Figure 1 Conceptual model of the construction project as a social network

database – media and user attendance, for example – and this information will be tied to the related media or user profile.

The final sub-category is “updates.” This sub-category is a database which records the most recent changes to the project system and provides that information to the users.

4. ADOPTING THE SNC PARADIGM

Features of SNC and the social networking paradigm are already being adopted for other applications and industries. Most notably, major email providers such as Google and Yahoo are attempting to develop their own social networks by integrating and expanding their standard email services (Hansell, 2007). As emails represent the connections between people, the email providers already have the framework for establishing a SNC. Other features, such as organizing emails by relationship strength, displaying profiles of email correspondents, and a news feed with status updates from friends, are all inspired by the social networking paradigm.

The social networking paradigm itself is constantly changing as different networks compete to provide the best service and attract more users. Facebook garnered a lot of attention for allowing outside developers to build programs which can be

integrated into the Facebook system and made available to users (The Economist, 2007). Google and MySpace are also considering such a move in order to compete with the Facebook model (Gershberg, 2007).

4.1 SNC for the construction industry

While the social networking paradigm and its features have already been covered, the question of how to adopt these for application to the construction industry has yet to be discussed. Consideration must be given to how the construction industry operates, and how SNC features can be applied to help solve information management problems.

Social networking could conceptually be applied in two ways. The first is project-focused. In this model, the social network is built around a construction project; the actors are the project participants, and the information to be exchanged belongs to the project. User interaction is purely within the bounds of the project scope. The second model is a professional social network for the construction industry. This model may be utilized for the sharing of experience, new ideas or techniques, and would act as a forum for establishing professional ties and increasing collaboration between different members of the construction community. In this case, the information exchanged may be related more to the users. The research works surveyed in Section 2, as well as the conceptual model given in Figure 1, are of the former social network model. In the latter model, the social ties are established by the users themselves, which is more similar to existing Web-based SNC, and may be based on field, personal or research interests, and so forth.

Information control requires consideration when proposing the adoption of social networking. In the Web-based SNC model, information is controlled by each individual user, who can choose how much to share and with whom. Assuming the construction project as a social network, the exchange of information may not be decided by each user, but restricted by legal or contractual guidelines. Previous research works have already shown that there is a flow to information in construction projects. Therefore, any social networking system would need to be programmed to follow the legal structure established by the contract documents.

Information security in a construction project is vital in order to protect the interests and investment of the parties involved. Other industries have already provided Web access to secure information for their customers, so they have discovered the vulnerabilities in adopting the Web paradigm and are continually readjusting their services to account for new security threats. As the Web paradigm is relatively new to the construction industry, problems relating to information security are not entirely clear. However, research into the problems experienced by other industries, combined with an investigation of the needs for the construction industry, would provide necessary background information for developing security in information management systems.

4.2 Concerns with social networking

Even though the popularity of social networking is growing rapidly and many companies are investing in the technology to increase their social networking strength, the SNC paradigm may not be appropriate for all businesses. While the construction industry appears to be an ideal application for social networking, its specific needs should be further studied in order to verify how to properly adopt this developing technology.

5. CONCLUSIONS

A survey of the past research works found that using a Web-based database and interface reduced mistakes and increased accessibility, which resulted in reduced project costs. However, these works did not acknowledge the paradigm for social networking establish by Web-based SNC. This paper proposed the study of Web-based SNC for the development of information management systems for the construction industry.

Web-based SNC allow users to interact through a common interface anywhere they can access the Internet, at any time. In order to create a simple and intuitive means for these users to share data, tools were developed for the organization and exchange of information. Tags are a means of labeling the contents of any type of media, allowing users to generally know the contents of a file without having to survey the entire file. Tags can be more than just keywords, though – they can also be users or events. Organizing data by using tags allows for the quick grouping of any type of information which is identified by a given tag. A conceptual model of the construction project as a social network was developed using these tools for the management of information.

While these tools may be easily utilized by the construction industry, other features of the SNC paradigm cannot be easily transferred. Information control is an important part of effective construction management. In the normal SNC paradigm, information flow is generally free, restricted only by user controls on privacy. However, on a construction project, information flow may be dictated by contractual or legal requirements. Therefore, controls need to be established to respect the legal structure of the contract. To develop these controls, studies need to be performed to understand the relationship between information flow and control and contractual agreements. Such studies should also investigate the importance of information security in the construction industry. While other industries have already adopted the Internet as a means for exchanging information, the construction industry does not have such experience. Therefore, background information should be gathered to clarify the role of security when developing an information management system.

There are two ways in which social networking could be adopted by the construction industry. The first model uses the construction project as the tie between actors in a network; information exchange in this model is restricted to that relating to the project. In the second model, the social network encompasses the field of construction; the role of information and management exchange is for the enhancement of industry knowledge and increased collaboration.

Regardless of which social networking model is adopted, the applicability of the SNC paradigm for construction should be thoroughly investigated and understood. As indicated by past studies, contractors are hesitant to adopt new IT technologies; therefore, the benefits and problems of this paradigm for managing information should be made clear before practical adoption of the model by the industry.

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