IMPLEMENTATION OF WEB-BASED INFORMATION TRANSFER AND COMMUNICATION SYSTEM IN CONSTRUCTION: LEADS TO FUNCTIONAL ANALYSIS

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Abstract: Construction industry is an information-intensive industry. Recently, there is an increasing interest in web-based information system in the construction industry, e.g. Web-based project management systems, Web-based information transfer and communication systems. Some systems are now being commercially available and used worldwide. However, the implementation and utilization of such systems is still unsatisfactory. The lack of adequate functional analysis is believed to have a significant impact on this issue. This paper will review the literature and illustrates some existing systems. The purpose is to define the problems related to their application in the industry. It finally concludes the necessities of doing further research on functional analysis of these systems to ensure increased success of their implementation in construction organisations.

Key words: functional analysis, information systems, web-based systems,

1. INTRODUCTION

Construction industry plays an important role in the economy. According to the Egan’s report (Egan, 1998), in the UK, the industry had an output of some £58 billions in 1998, equivalent to roughly 10% of GDP, and employed around 1.4 million people. The industry is, however, very fragmented. It consists of hundreds of thousands of firms but 97% of private contractors firms employ fewer than 14 people (HMSO, 1994). Most construction projects often involve an ad hoc team of numerous design firms, consultants, contractors, subcontractors and suppliers located at disperse places and the project team changes from project to project. Similarly, most of the clients are usually one-off clients. So, there are few instances of long-term alliances and stable supply chains, unlike manufacturing industry. This situation of fragmentation often causes poor interdisciplinary communication.

Also, construction projects are invariably complex and become progressively more so in recent years. In fact the construction process may be considered as the most complex undertaking in any industry (Bennett, 1991). The design and construction of a building is a complicated process (Howell, 1999). This is partly resulted from the fragmented nature of the construction industry. Other reasons include the industry production processes and the products themselves are unique compared with other industries. Also, construction processes are long-term and out-doors work. Many factors, e.g. natural, political, economical and cultural, may impact on the processing and the completion of the projects. As a result, it has serious adverse effect on the efficiency and productivity in construction industry.

Due to the nature of fragmentation and complexity, construction is one of the most information intensive industries. During the construction process, a lot of information is produced, such as drawing and photos, cost analysis, budget reports, tendering and contract documents, and so on. Thus, the timely and accurate information transfer and communication between all partners is crucial to the success of projects. Research shows that wasting of time and cost in construction projects can be traced back to poor coordination caused by
inadequate information – insufficient, inappropriate, inaccurate, inconsistent, late or a combination of them all (Deng et al., 2001).

With the rapid development of information technologies and the wide spread of Internet applications, more and more corporations and individuals begin to develop their businesses with the help of Internet utilities. This trend has become one of the most significant characteristics for the construction industry in the new economy and it will still be enforced in the future. Some researchers and system vendors have been paying much attention on this field and a fundamental work has been done. Recently, many Internet-based information systems, e.g. document management system, project management system and information transfer and communication system, have been introduced worldwide.

However, the application of such systems is not so satisfactory. Many factors are impacting on their success (Nitithamyong and Skibniewski, 2004), which include some inherent weaknesses and limitations. This paper aims at reviewing the literature in this area and to explore some popular existing systems. The purpose is to study the implementation of such systems and define the problems in its application in the industry. It finally concludes the necessities of doing further research on functional analysis of these systems.

2. PREVIOUS STUDIES

Information transfer and communication has been regarded as the important issue in IT implementation. As Biork (1999) said: "Information transfer throughout the construction process, between organizations, life-cycle stages and engineering disciplines is a primary research area for ITC". In the report of Sarshar et al. (2002), information transfer and communication have also been highlighted as two of seven themes of construction IT vision, i.e. "Life cycle thinking and seamless transition of information and processes between life cycle phases" and "Improved communication in all cycle phases, through visualisation".

So far, a great deal of research has been undertaken to reveal the issues of information transfer and communication in the construction industry, and numerous articles, working papers, reports, conference proceedings are published all over the world. Many of them have realized the potentials of Internet technologies and intend to utilize the newly Internet applications to improve and enhance the productivities in construction. As Bridges (1997) identified, Internet technology has the great potentials for managing construction projects, because data can be received transparently from either a local disk or a remote website that provides a communication point for client, designer and contractor. This section will review these works and outline their findings.

The earliest studies on Internet-based information transfer and communication system were undertaken by Tam (1999) and Deng et al. (2001). They worked on a same system which is named as Total Information Transfer System (TITS) and comprises of six major functions, including: data exchange with FTP and Telnet, information transfer with E-mail, Internet chat, live video-cam on site, search engine and auxiliary services. This is a primal system but, with it, they discussed some important concepts and principles and analysed the cost-benefit of this kind of system.

Thorpe and Mead (2001) noticed the information overload problems in construction and implied that project-specific web site could partly solve it by eliminating information push and enhancing information "pull". In their research, they gave an organizational structure of a project management website and then studied some cases with Social Network Analysis. They finally concluded that the project specific web site can speed the information flow and communication, but it depends on the participation of key members in the project.
Weippert et al. (2002), Weippert et al. (2003) and Thorpe (2003) worked on a same project-centric and Internet-based information and communication system (http://www.projectcentre.net), which commenced in 1999 and is now commercially used in Australia. These works represent the different perspectives and evolutions of this system and displayed the preferences of end-users of this system. Some critical factors impacting on the implementation of this system have also been discussed and concluded.

Alshawi and Ingirige (2003) reviewed previous research works and some developed systems. They made some important conclusion about the limitations of traditional project management practices, the influence of Internet on project management and communication, the stages and functions of web-based project management systems. Through the comparison of several existing systems, they listed the benefits and problems of web-based project management systems respectively.

Although many publications are mainly discussing the implementation and application of such systems from technological or organizational perspectives, there is also much literature discussing some further topics in this area, especially in recent years. Among them, Sulankivi (2004) discussed the benefits of centralized information management in multi-partner projects. Stewart and Mohamed (2004) introduced a framework to evaluate the value IT adds to the process of project information management. Nitithamyong and Skibniewski (2004) completed a much deeper research on the factors impacting on the success of web-based construction project management system. Their works represent a new trend of the research in this field, i.e. the research interests have been attracted from the general topics to more detailed and specific topics. The problems occurred in the stage of system implementation have now been attractive to the sassy researchers.

3. MODEL OF EXISTING SYSTEMS

With the development of Internet-based systems, some frameworks have been described and adopted. It has been widely accepted that these systems are set up as the project-specific or project-centric ones. That means all participants exchange information and communicate via a centralized mechanism. Figure 1 illustrates two similar frameworks of these systems, which extracted from Dawood et al. (2002) and Weippert et al. (2002).

![Figure 1 Macro View of Current Systems](image-url)
According to this framework, the systems comprise of a central web-enabled database and a number of client servers and user interfaces. This database is the core of this framework and every authorized user, such as client, architect, contractor and project manager, can use his remote workstation to access the database through the Internet, to browse, search for, and upload or download their needed information. This central system is designed with the universal Internet protocol and technologies. So it only requires all participants have an Internet-accessed computer and web browser which enhanced with some plug-in applications. It can obviously reduce the repeated investments on hardware and software.

The well-recognized advantage of such system is, within this framework, all participants don’t need to have direct links with other partners. The information transfer and communication are achieved through the central system. Thus, it provides a clear interactive linkage among all participants and simplifies the relationships among participants from multiple-to-multiple (participants-to-participants) to multiple-to-single (participants-to-system), and consequently, reduces the number of linkages and possible errors dramatically.

Further to this macro model of such systems, some research has been undertaking to demonstrate the system from the micro view. In their recent work, Liu and Kagioglou (2004) proposed a typical model between construction contractor’s headquarter and the jobsite. It also shows typical connections and devices accessing to the system and the relationships among the participants (see Figure 2).

Within this framework, the centralized system provides a hub for exchanging and communicating between all participants within the company, either in headquarter or in jobsites. All staffs can access this system through different methods. For the headquarter side, the access to the system is almost fixed, compares to that in jobsites where mobility is more significant. A local area network (LAN) could be built in order that all computers can access the system via a firewall-equipped server, while direct access of individual computer is also available. For the jobsite side, although desktop is still a first choice for many of participants, the laptop and other hand-held devices could be the ideal alternatives for the mobile foremen, engineers and managers. This figure illustrates the major and possible access approach and devices accessing to the system. To some extents, the accessibility is a dominant factor impacting on the adoption of this system, because it is the least requirement for implementing the Internet-based system.

The system also provides the interfaces for the participants outside, who would be client, sub-contractors and suppliers, by allowing authorized users log onto the system with their username/password. Their accesses to the system are similar to that within the contractor’s company. Thus, the central system links all participants together and makes them exchange information and communicate with each other.
4. CASE STUDY

This project-centric mechanism has been accepted by the industry. Based on it, a lot of commercial systems or software have been developed and implemented worldwide. As an example, Buzzsaw gives us a better understanding to the systems, which is one of the family products of AutoDesk Inc., the vendor of the famous CAD software – AutoCAD.

Buzzsaw is a web-enabled project management system. By using this system, the paid user can create his Buzzsaw project site in order to manage the project information. This system is designed with the document management centre which file structure can be customized to fit into different major user’s needs. The authorized users can access it through two web-based clients, i.e. Buzzsaw client and HTML-based “thin” client, which can be downloaded on the AutoDesk’s website free of charge. After the major user has got the authorization to access this system by paying a certain cost, he can then log into the system and creates his own project site. This procedure is as simple as creating a single web-page and finally produces an info-page with the web-link like http://projectpoint.buzzsaw.com/client/yoursitename/yourprojectname. The project info page is a great way to share information with all members of the project. What they need are only a web browser and a username/password. The major user needs to assign the other partners corresponding authorization and permission. Then the other partners can log into the system and exchange the needed information via this system. The system accepts the following formats of documents: HTM or HTML, JPG or GIF, TXT, DWG or DXF, DWF, DOC, XLS, PPT, PDF and EFX. When needed, the web viewer or user’s applications will be introduced to view associated documents.

Figure 3 shows a screenshot copied from Buzzsaw. It shows the interface of the web-enabled system. From it we can find it has the similar interface as other windows software. So, users don’t need to spend much time on learning how to use it. It has some important
features. Among them, Project Selection Bar allows the user switch the projects from one to another. Buzzsaw Bar provides the functional shortcuts to manage projects. Project Navigation Bar allows users choose what they want to view on the details view field. By using these web-enabled tools, the system has provided the possibilities for the industry to transfer information and communicate with each other.

According to the whitepaper of Autodesk, this system integrates several functions that FTP server, Email and Web hosting can provide. But, because it is a subscription-based system, the expense is only 42% of the total cost of ownership of other alternatives (Autodesk, 2002). This is significant especially for the SMEs in the construction industry. Most importantly, this system provides the industry an integrated system to manage the shared information among all parties of a project and helps the parties to increase productivity, improve risk management, reduce cost and gain a competitive advantage by improving team communication and the coordination of tasks and activities.

5. LIMITATIONS AND WEAKNESSES OF CURRENT SYSTEMS

Although current systems have made an obvious achievement in solving the problems of information transfer and communication, there are still many unsolved difficulties. Besides the general problems of implementing new IT applications such as IT knowledge, funding, infrastructure and etc, there are some issues that can be regarded as technological problems. Among them, the lack of data standardization has been proved to be the major obstacle for information exchange and many other computer-integrated construction research efforts (Dawood et al., 2002).
As we found, there are now many different systems to be implemented commercially. But the absence of standardization results in the incompatible systems. This situation brings about the most negative impact on the adoption of web-based systems, as construction projects always involve a number of partners in the form of one-off team. So, when having to face different systems and different interfaces from project to project, or even not to use these systems at all, the partners are becoming reluctant in adopting it. They cannot forge the long-term and strategic relationships with other participants by using this kind of systems, especially for the users of third-party developed ones.

At present, this issue has been paid attention by practitioners and academics (Ingirige et al., 2001) and many standards have been introduced. But, a common standard hasn’t emerged yet. This limits the deployment of Internet-based systems significantly.

It is expected that an Internet standard will occur within this decade (Unger, 2002). Some major contractors and owners that have gained benefits from the tested Internet-based systems will push them to their partners. In this regard, XML (eXtensible Mark-up Language) seems have a great potential. But there is still a long way to go before the integration of information standards and Internet-based system.

Another major problem was found during the actual utilization of these systems. As they are using a central database to exchange information and communicate, the direct linkages between participants are ignored. To some extent, some systems are overemphasised and make themselves over-dependent. Participants will be forced to obtain the needed information from the systems other than from their partners directly. Thus, if the systems cannot provide any value-added applications, they will purely play the role of information intermediates and become the generator of time wastage and inefficiency. This is contradicting with the purpose of Internet-based systems.

On the other hand, the abuse of E-mail and other computer mediated systems, such as video-/ tele-conferencing can “make people lazy” and less likely to partake in face-to-face communication, i.e. so-called “interactional difficulties” (Rozell and Gardner, 2000). It unexpectedly brings about the communication difficulties and hampers the informal communication which proved necessary in construction process. And, finally, the daily works are inundated with the ocean of information.

Related to this problem, another issue is that the central database needs to be accessed conveniently when necessary. As Thorpe and Mead (2001) observed, the project teams “need this stuff in real time”. However, because of the one-off and out-doors natures of construction process, the convenient and uninterrupted accessing methods cannot be provided by traditional means. It would even be the nightmare to the staffs on sites. Just imagine how the foremen rush back into their office from the busy jobsite, only to send or receive the needed information, or communicate with other partners.

Further to the issues aforementioned, there is still a debate among A/E/C firms whether or not to move permanently to web-based systems (Kraker, 2000). Many companies would believe that the advantages of these systems are only the claims of systems’ vendor for their marketing purposes. The factors of impacting on their implementation are not clearly identified and the systems in the market are also very primal and immature. The following section will discuss some directions in the further research.

6. SUMMARY AND FUTURE RESEARCH

O’Brien (2000) has indicated that the implementation and sociological issues associated with the project web sites must be addressed before they can be truly successful communication vehicles. He further listed some issues and gave the recommendations for development.
Aiming to resolve or decrease the issues from the technological perspective, we recommend doing relevant research works in different areas. In Figure 4, we summarize some major areas that have obvious problems and need to be resolved.

As Figure 4 shows, the technological difficulties are grouped into four categories: lack of standard, over emphasized or over-dependent systems, centric hub’s restriction and communication obstacle in dispersed sites. These issues result in three major problems when using web-based systems, i.e. incompatible systems, ignored inter-personal communication and higher dependence on devices. From our opinion, these problems can be resolved with different solutions. For example, standardization might be adopted to produce more compatible systems. Also, through the analysis of the system’s usability and accessibility, we can find out how the information is stored and exchanged under the complicated construction environment. Furthermore, the suitable accessing methods (e.g. wireless connection) and devices (e.g. mobile phone or personal digital assistant) can be developed to meet the needs of construction industry. But, among these potential areas, our research will focus on the functional analysis, to find out what the users’ needs are and how the web-based systems meet the needs.

This topic is significant and practical. From the aforementioned researches and currently developed systems, numbers of functionalities are introduced and implemented. In their white papers and press releases, the system vendors also declare that they can provide more comprehensive and competitive functions in comparison with their competitors. However, what functionalities are, in the user’s view, really necessary and beneficial? What are the basic but essential functions? And how these systems meet the requirements for the industry? So far, no publication could be found in answering these questions. It is unsatisfactory, as the system end-users might be sensitive to these questions before they make the decision to adopt this new technology or not.

Some other researchers have also noticed this problem and recommend doing further work in this issue. As O’Brien (2000) suggested, it is important for A/E/C (Architectural,
Engineering and Construction) firms to have a specific feature and think through how this feature would interact with the job tasks of project team members. Andresen et al. (2003) have also addressed that there is a continuing need to improve the functionalities of project webs. Clearly, our research will be a response to these researchers.

To complete this research, we intend to start it from the desktop works, which includes the identification of user’s needs and enumeration of as-is functions through the exploration of existing systems. Then we can find out the gap or match between them initially. After that, the suitable methods will be discussed and introduced to do the further research. Research survey, questionnaire and case study might be used at different stages. At last, we will make the conclusion and put forward to the to-be functions and prototype of such systems.

We are now in the process of doing this research. Some results are to be expected with the next 1-2 years. Of course, it is hoped to benefit from the discussions and are open to suggestions on collaborative research in this area.

7. REFERENCES


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