

SUGGESTIONS FOR IMPROVING ADOPTION OF ONLINE COLLABORATION AND PROJECT MANAGEMENT TECHNOLOGY

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This research focuses on current problems and inefficiencies of implementation and operation of Online Collaboration and Project Management (OCPM) technology in the US Architecture, Engineering and Construction (AEC) industry. Despite the enormous number of the solutions and claims about their advanced technology and benefits, the adoption of these tools by the industry stakeholders has been very slow. Unfortunately, the huge amount of technology is presented without targeting the evolving communication & collaboration necessities of the industry. In an attempt to fill the need of research to explore how these tools actually interact with the organizational context, what the needs of the users are, and how this technology can be improved and commonly adopted by the industry, three active construction projects were studied and a user survey was conducted. This paper outlines the findings of one-year research and concludes with “Critical Enhancement Areas” that would hasten the adoption and successful implementation of these tools by the AEC industry. The study enforces that success is less about adding more advanced technology but it is more about using the available technology in a more reinforcing way to solve business problems and obstacles regarding the adoption of these tools.

Keywords: AEC Industry, Collaboration, Communication, Extranets, and Project Management.

INTRODUCTION

The real estate and construction industry is the largest industry in the world with distinctive characteristics such as fragmented organizations, the uniqueness of each project, relatively short period of production, outdoor and unstructured working conditions, and labor-intensive activities. Successful completion of construction projects requires communication and collaboration of numerous multidisciplinary and sometimes geographically separated team members. Continuous and accurate formal/informal communication among project participants is key to resolve conflicts, keep the project on time, on budget, speed up solutions, and to share knowledge for coordinating these efforts.

The rapid advances of OCPM technology offer new opportunities to improve existing construction project communication and enhance the collaboration. However, despite many benefits of these technologies and all the efforts that have been put into facilitating the communication among the participants in AEC projects, utilization of OCPM technology hasn't progressed beyond simple document storage, exchange and management. (Kalay 1999) There is a strong resistance from the industry participants

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to adopt these new tools in their full capacity and change how the work has traditionally been done. By late 2001, only 40% of General Contractors had tried project collaboration software according to Construction Financial Management Association's 2002 Information Technology Survey for the Construction Industry. The huge amount of technology is presented without targeting the evolving necessities of the industry. (Becerik 2004) There are serious doubts whether these products will provide the level of flexibility that teams demand. Moreover, there is no clear understanding of what the communication and collaboration needs and desires are in the AEC industry. (Castle 1999) Many improvements are needed for the OCPM tools themselves and how they are implemented in order to move the industry beyond the functionality of current working methods, and provide a real breakthrough in communication and collaboration effectiveness.

OCPM TECHNOLOGY

The term "*OCPM technology*" in this research refers to any number of web-based and web-enabled technologies, which offer communication platforms, project management functionalities and hosted collaboration spaces for capital construction projects. Unlike a web-based application, a web-enabled application is not based on the HTML language, but is instead a special software application that is distributed across the Internet much like standard network programs that are accessed over a Local Area Network (LAN). In both of these configurations, team members can reach the project information through their Internet browsers with permission-based access requiring user names and passwords. Although business models vary among OCPM providers, these services are typically leased for either a periodic and/or per-user fee. OCPM technology is being used for facilitating team communication, managing and storing documents, controlling workflows and automating construction processes. These tools enable project participants to send, record, store, share, receive, monitor, and manage correspondence, Request for Information (RFI), drawings, specifications and other documents involved in the design and construction processes.

RESEARCH GOAL AND METHODOLOGY

This research has been supported by General Services Administration (GSA), which is the world's largest landlord of the civilian federal government, and by Harvard University. The aim of the research is to explore: *How these tools actually interact with organizational context, what the needs of the industry are, and how this technology can be improved and commonly adopted by the industry.*

Typical questions answered in this paper are: *How are OCPM tools used? What are there benefits from implementations of these tools? What are the barriers to widespread adoption? Which and how technical questions need to be solved?* To accomplish these goals, three GSA construction projects have been studied. Using case studies has been important as an empirical investigation of OCPM technology within its real life context as the research required observing and then evaluating the benefits and the shortcomings of OCPM tools and also learning from users' experiences. In addition to the case studies an online user-survey has been conducted to identify the factors associated with successful implementation of these tools and to get user opinions on the impact of these tools on team performance and project outcomes.

CASE STUDIES

GSA helped to identify three construction projects to get in-depth analysis of implementation and usage of OCPM technologies. In addition, GSA provided access to the project information and helped to contact the projects' participants. Each case study focuses on new construction with traditional project delivery method (design-bid-build) and has different scopes. All projects were managed by Construction Management agencies acting as GSA's representatives. The cases are ten to fifteen pages long and are structured with the following sections: project overview, OCPM technology, selection process, realized benefits, improvement areas, and conclusions. A common challenge for the project teams was working with a number of team members from different disciplines that are geographically distributed. A brief outline of the case studies' statistics is provided in Table 1.

Table 1: Case Study Statistics

Statistics	World War II Memorial	NOAA Satellite Operations Facility	Miami Federal Courthouse
Client	American Battle Monuments Commission	National Oceanic and Atmospheric Administration	General Services Administration
Project Manager	GSA	GSA	GSA
Building use	Memorial	Computer Facility	Courthouse
Size	322,345 SF	208,271 SF	577, 784 SF
Construction cost	\$71,677,602	\$53,757,000	\$129,254,000
Project cost	\$101,039,255	\$61,198,000	\$163,022,000
Design period:	06/08/98–11/21/02	02/05/01–09/28/02	08/10/98-12/18/02
Constr. period:	08/27/01–03/05/04	04/30/03–05/18/05	07/16/02–05/16/05
Constr. status:	97% complete	20% complete	51% complete
Design OCPM	Citadon, Inc	Citadon, Inc	Framework Tech.
Constr. OCPM	Prolog, MPS	Constructware	EdgeBuilder

SURVEY

A more qualitative research was required to explore the needs of the users and also to learn more about the impact of these tools on team performance and project outcomes. The aim of this survey was helping the author to evaluate the strengths, weaknesses and benefits of OCPM tools, areas of improvements, and implementation inefficiencies from the end users perspectives. The first section of the survey was "General Information & Implementation" in which the respondents were asked to provide information about the tool implemented, the project, their background and roles, their experience level with OCPM tools and other communication and collaboration technologies. The second section of the survey was titled "Effectiveness of the Tool". It examined the perceived benefits of the tool in the specific implementation, user opinions regarding the importance of the OCPM tool compared to other means of communication technologies, evaluation of various aspects of the tool to be effectively used, and suggested improvement areas.

DATA COLLECTION METHODS

Interviews

The information requested in the structured phone interviews was straightforward and didn't involve sensitive material, so potential bias was low. Prior to the interviews, requests were sent to the project managers and the administrators of the OCPM tools to identify the most suitable people as respondents. Major participant stakeholders with various roles have been interviewed for each project. The interviews deepened the author's understanding of the step-by-step logic of a situation as it occurred, the interviewee's experience with the tools, the lessons learned in the project and the users' opinions for improvements areas.

Table 2: Short Interview Questions

#	Questions
Q1	How did the team decide to implement OCPM tools in this project?
Q2	How was this tool selected?
Q3	What kind of training, for how long, and by who was it provided?
Q4	What were the attitudes of your colleagues & management towards OCPM technology?
Q5	How did the project & your firm benefit by implementing this technology?
Q6	What were the problems with the implementation and usage of the tool?
Q7	How did the management and the technology provider address these problems?
Q8	What should have been done differently?
Q9	What would you recommend for improving the implementation and usage?
Q10	How would you rate the overall effect of the OCPM tool on project performance?

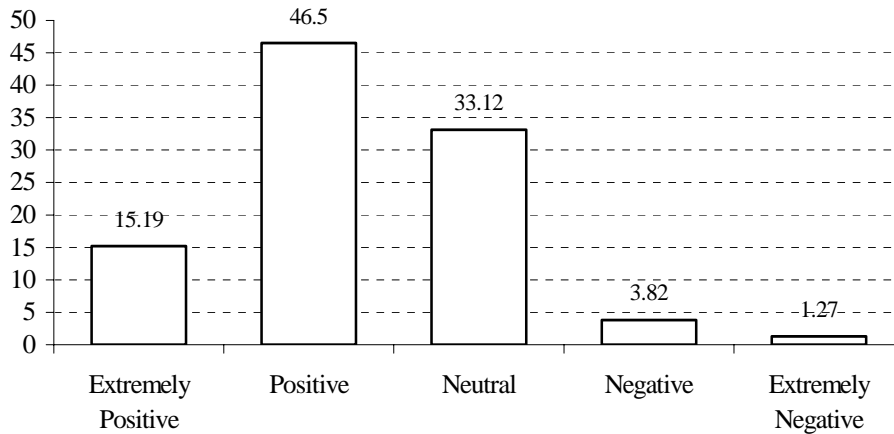
Survey

Many OCPM technology users at GSA, including the participants of the case study projects, were invited to respond to a voluntary online survey of twenty questions. The contact information was requested from the system administrators by online "administrator survey". The invitation to the survey, including the Internet link of the user survey, was sent directly to 400 users via email in mid-February 2004. The answers were collected between February 2004 and May 2004. The answers provided are kept confidential and have been used for statistical purposes in aggregate form only. Not all of the OCPM users of the projects were able to complete the survey due to other commitments and time constraints. However, sufficient users completed the survey such that the author was able to identify certain common problems, issues and limitations experienced during the implementation and usage of OCPM tools.

CRITICAL ENHANCEMENT AREAS

OCPM technology holds a great promise. The overall effect of OCPM tools on project performance is positive according to 46.5%, extremely positive according to 15.19%, of the users. (Fig 1.) 81.17% of the users indicated in the survey that their company anticipates using an OCPM tool for upcoming projects, however most of them also indicated the technology needs improvements and the implementation has to be rethought. This technology is surely bound to replace "old economy ways", but only if the tools can adequately fulfil the specific needs of the users.

Figure 1: Overall effect of OCPM tool on project performance



The future is inevitable, but slow at the same time. The question is: *are we going to wait for the next generation to overcome obstacles eventually or try to hasten the process and eliminate the inefficiencies as soon as possible?* In an attempt to hasten the process, the following enhancements have been identified as critical for the adoption of these tools by the AEC industry based on the formal and informal interviews with the end users; the lessons learned from the case studies, and analysis of the online user survey.

Robust Tools Should Fit the Nature of Construction Projects

Design and construction are inherently different processes, shaped by reality. Design is decision intensive, encouraging study and redesign. Construction is production intensive, with defined needs for labour and materials in fixed timeframes. During specific phases, coordination and collaboration may be required in different levels. Participating organizations and the tasks they perform may vary during the project phases while the shared information should be kept stable throughout the life cycle of the project. Managing construction projects is an interdisciplinary art requiring professional skills to achieve the maximum performance.

It has been observed from all of the case studies that there are no tools that would fulfil all stages of the construction projects. Today there are some OCPM tools that focus efficiently on workflow and process automation during the construction phase, and there are others that are very good at enabling team communication and document management. Therefore, the project teams have to shift products during different stages of the projects, which results in knowledge, time and money lost due to data re-entry, learning curves, and productivity drops. These tools should support the project team during all phases of construction projects with variable and flexible modules.

Flexible Tools with Customisable Modules

AEC organization is based on “temporary networks” of architects, engineers and contractors forming and reforming into corporative groups for each project. (Kornelius 1998) Therefore, OCPM tools should be flexible enough to align with differing structures of project teams, project types and delivery methods. For example, in all of the case studies GSA hired a construction manager to act as the owner’s representative, supervise/inspect the general contractor and oversee several consultants. In this team structure, almost all communication and document flow goes through the construction manager. However, most of the available tools are built according to a traditional delivery system where architect and general contractor communicate directly. Moreover, the tools are very rigid and don’t allow the team to

modify the modules to accommodate their needs. In the end, either the teams find a custom-built solution, which is unpractical, difficult to use that cause many delays and frustrations, or they stop using the modules.

Another common problem among the current solutions is that most of them aren't built by people with construction knowledge and experience. As a result, some of the modules and processes observed in the case studies were reported to be poorly designed and insufficient. The tools should be developed in conjunction with construction experts, so that their understanding of the way work needs to be done in AEC industry can be built into the tools.

Intelligent Workflows

As the world moves towards intelligent data structures, the technology providers should also move towards intelligent tools those will deliver rich, dynamic information rather than passive solutions that deliver static reports. Current OCPM solutions are very document-oriented, which leads the industry to move towards shuffling electronic paper rather than encouraging truly electronic processes. In fact, even having *electronic paper process* has clearly demonstrated that the industry could gain efficiencies, but the tools need more *intelligent workflow* to survive in the future.

Design and construction processes have unique workflow issues that are not found in other industries, such as extensive and lengthy RFI cycles, multi-stage building code performance checking, etc. Workflows unique to construction projects have to be modelled and built into the tools carefully. The tools should be intelligent enough to manage the processes without any manual help or data re-entry. They should have automated management systems with decision making, data gathering and implementation capabilities. Intelligent workflows should have the ability of explicitly describing and understanding the current real-time status of the project, and the purpose of the planned processes, then determine what activities to undertake and in what sequence according to its experience, also adjusting and modifying its actions in response to any changes. (Huang 2003)

Future OCPM tools also should automate tasks between business partners. For example invoices or purchase orders can be exchanged automatically and fed into back-end systems to track shipments, all from within the corporate portal without having to log on to several information sites. As such relationships extend across more companies in the supply chain, this technology will become part of an industry-wide supply chain integration solution. By linking more companies in the value chain and providing better integration of the information shared by each company, these intelligent OCPM tools will enhance the reach and integration of the supply chain.

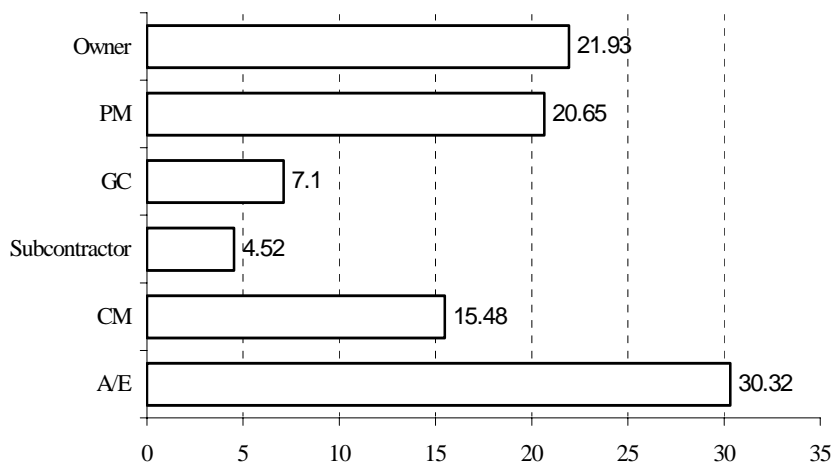
Client/Server with Internet Capabilities

Despite all the developments in information systems, the AEC industry is still in the paper world. The predictions were that the industry would move towards web-based models, however one of the difficulties observed in all of the case studies is that connectivity is still a problem. Often the speed is slow due to the number of the users or/and amount of information stored in the system. Most of the contractors, subcontractors, suppliers, and construction sites are completely disconnected. This can also be observed from the respondents' profiles of the survey in Figure 2. General contractors and subcontractors replied to the survey are 11.73% in total, which shows that the usage of the tools drop down dramatically down the value chain. All of this creates a situation where paper-based processes have to line up with OCPM (if

implemented) in AEC projects. In addition, the reason for up to 65% of contractor rework is related to insufficient, inappropriate or conflicting information. (Newton 1998)

OCPM tools are designed to benefit all project participants. The maximum benefit is achieved only if all actors involved in the project exercise their options simultaneously by investing the required resources in the system. If this is not the case, the full potential of the investment is not reached. In an industry that is characterized by both decentralized decision-making and conservatism, it is not clear that the end-users will adopt a new technology as enthusiastically as the corporate IT department. (Amram 1999)

Figure 2: Respondent profiles

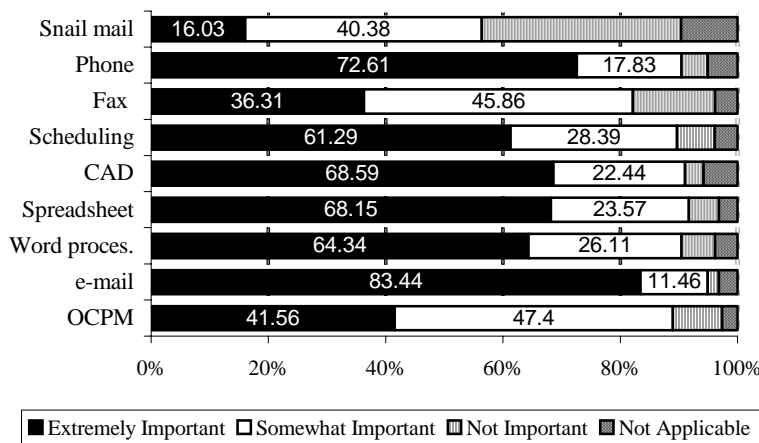


Therefore, solutions should be able to work on client server databases to avoid connectivity problems. The tools also should have Internet capabilities as the technology spreads out and keeps developing. As many of the team members who were interviewed mentioned, the tools should be set up for a wide area network with an Internet component, so that everybody could share and there is no need to upload the files to internal servers. (E.g. for printing construction documents)

Capturing Paper Documents

The inability to share and interact with information easily and effectively is one of the biggest bottlenecks in using electronic information for collaborative decision-making in the AEC industry. (Liston 2001) The current situation in the AEC industry is that a mixture of different generation methods is used for managing documents. (Björk 2001) Today hard copy, telephone and fax dominate the exchange of project-specific requirements with suppliers and between the different project participants.

Figure 3: Importance of different applications for the project success



Telephone and email are the major communication tools that were identified in this research as being extremely important for project success, and the fax has lost some of its traditional importance. (Fig 3.) However, before arriving into any conclusion, the respondent profiles should also be considered. According to the case study observations fax is still a major way for transferring documents among downstream team members, especially among subcontractors, suppliers and contractors. Therefore all the information received by fax would have to be scanned either by the general contractor or the construction manager. So in most of those cases, two processes run in parallel, which results in less effective OCPM tools. Therefore, OCPM tools should have a system for all the documents faxed or emailed to be automatically added to the database. Actually this advancement is already being offered by some of the technology providers, as observed on the Miami Federal Courthouse. In this case a project email address is added to an email, which automatically adds the correspondence to the database. There is also an 800-fax number that assists the system in recognizing the document and saves it to the database as a PDF document.

Ease of Use

The respondents suggested (Fig 4.), and most of the project, members who were interviewed, agreed that the OCPM tools need to be re-designed to make the interface more intuitive and less complex. 70% of the respondents indicated that they believe they received adequate training. However it can be seen from Figure 5 that the comfort level of the users is still very low when compared to basic computing such as Windows, MS Office, and Internet and new computer technology.

Figure 4: Suggestions for improving the implementation of OCPM tools (multiple choice)

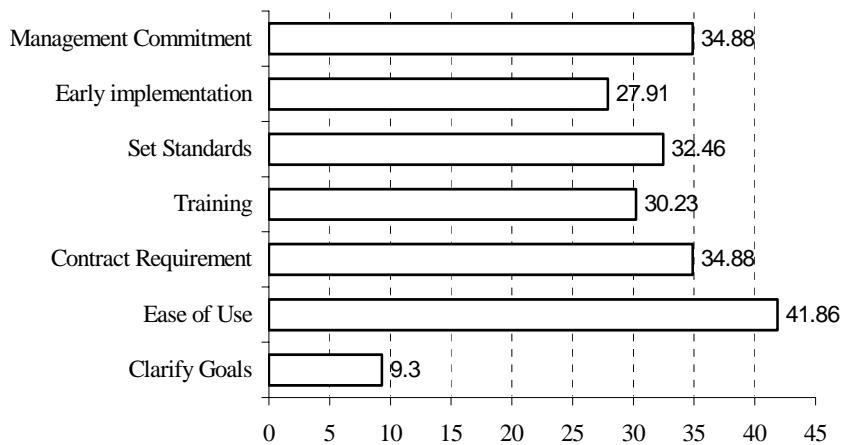
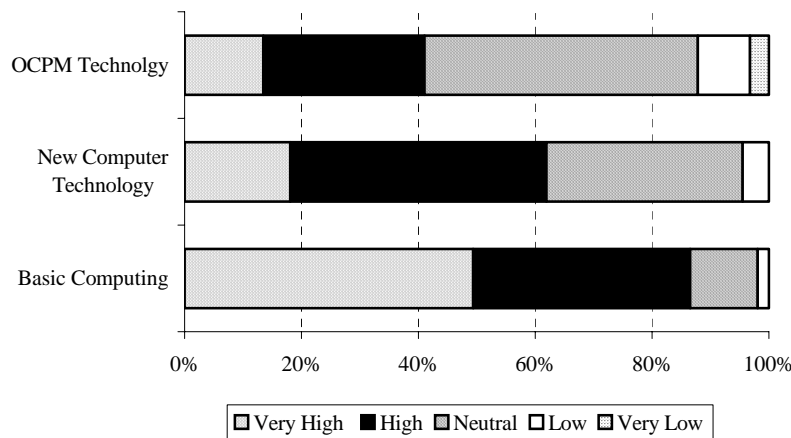


Figure 5: Evaluation of user comfort level with basic computing (MS Windows, MS Office, Internet), new computer technology and OCPM tools



These show that OCPM tools should be more self explanatory, intuitive and quick to learn like a Web search engine. The capability to search documents should also as far as possible resemble current practice, thus relatively simple hierarchical folder structures are popular with end users. (Björk 2003) Tools should dynamically adapt to the user’s skill level and expose as much functionality as the users are ready to use, and not more than they can handle. As a result, the tools can serve both casual and sophisticated users. The tools also should be adjustable to the user’s needs and display information relevant to the each user based on their position, role and responsibilities inside the project team.

In addition, integration with other applications should be improved. For example, there should be email interaction within the functionalities of these tools. A notification email is usually sent automatically to the responsible party/parties when an RFI is issued. The respondent has to connect to the OCPM system, find the RFI and answer it. However, it would be more effective for the system to have email integration, where email is encrypted for security reasons but there is no need to connect to another system. Similar to email integration, the tools should also have integration with Microsoft Office. For example, to see a Word document, there shouldn’t be any reason to download it to a local machine for editing. The tools should have Windows Explorer integration so that when the users click on the document, the tool presents a view in Word, and the users can edit/modify the document. Meanwhile,

the tool should automatically check the document out, and when the user saves it, the tool automatically sends the document to the database and creates a new version.

Desktop Integration

Today, a significant proportion of all computer applications provide some form of collaborative access even if only through interfaces to other applications. For example, Microsoft has already added collaboration features to Microsoft Project, and launched Office 2003 with inherent collaboration functionality to connect people, information and business processes. These developments indicate that collaboration is rapidly becoming an integrated part of operating system infrastructure. Microsoft SharePoint, which provides a server to allow teams to create web sites for information sharing and document collaboration, and aims to increase individual and team productivity, is free with Windows 2003. SharePoint supplies web sites with document storage and retrieval check in and check out functionality, version history, and flexible, customisable views.

It appears that collaboration is a dominant trend across the Information Technology industry and most of the software vendors see the value of providing collaboration functionality to improve the workflows among project teams. There shouldn't be a need for another software for sharing, storing and managing. There is a strong resistance from the users to learn and use another system. In order for OCPM tools to be adopted by AEC industry stakeholders more easily, they should be a part of or well integrated with the operating systems.

Interoperability

According to an online journal: ExtranetNews.com, there are a total of 270 extranet service providers operating in the US market as of May 2004. Of these, 82 only focus on the AEC industry. The user companies, which are intended to realize the benefits of these tools, usually find themselves having to use many tools to accomplish their work, and would prefer to utilize just one. For example, architecture firms are almost always obliged to use different products according to the different teams on which they participate.

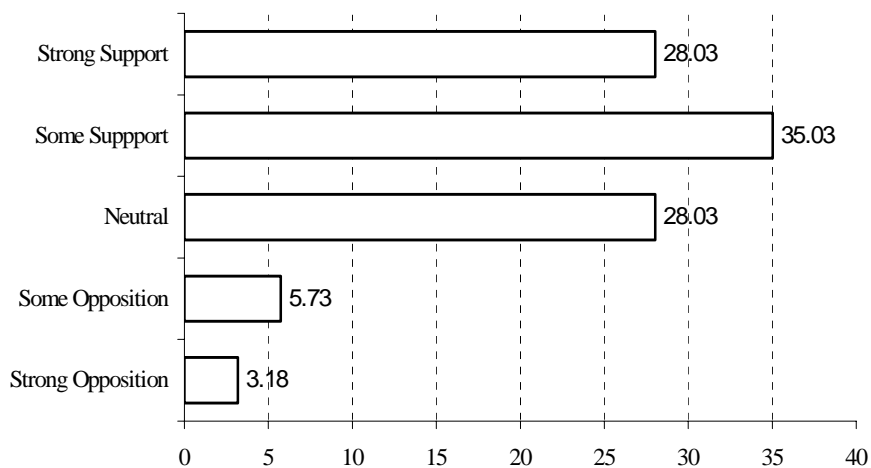
If the systems were interoperable, companies could use their preferred tool in any project. However, interoperability is a huge challenge. Vendor companies have little desire to become interoperable. If OCPM tools were designed to allow use of information in corporations' knowledge management systems, those individuals who didn't work on a particular project could benefit from the knowledge gained. However, the vendor companies will resist interoperability because they are focused on a battle for market dominance, both in the US and in the overseas markets in which many also operate. The value to the customers is obvious but the value proposition for the vendors remains undefined.

Strong Management Support & Contractual Requirement

The user survey shows that management-support is satisfactory for the projects in which the respondents participated. (Fig 6.) Management commitment and making OCPM tools a requirement of contracts appear as the second suggestion of the users. (Fig 4.) It has been observed from the cases that the presence of a champion along with the power of the owner to mandate is the most important factor contributing to the successful implementation and usage of OCPM tools.

The champions have to be technology savvy, understand the necessity to use this tool, the technology, and what it is offering for the job. Champions should be proactive and connected to the team. Success starts from the top and there should be a top-down buy-in by the project team. The project teams should not be only willing to use an OCPM tool but also understand its necessity. The team has to be willing to pay extra attention to make the tool work, because processes will be somewhat different than they have been used to in the all-paper world. Incentives must be in place in order to reward project managers for acting promptly as failure to benefit from platform investments is often due to deficiencies in the design of information flows and managerial incentives. (Kogut 1994)

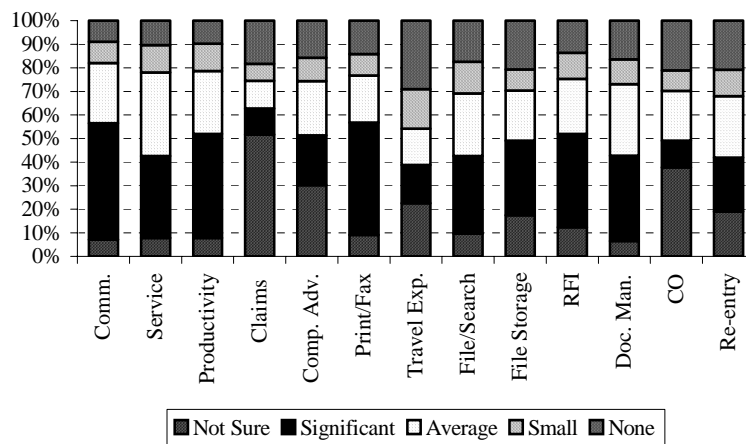
Figure 6: Evaluation of management support/buy-in for OCPM technology



Proved OCPM Technology Value Proposition

Unproven price-to-performance is another issue that prevents OCPM technology adoption. The primary motivator for actors in the AEC industry to adapt new technology innovations will always be the opportunity for direct gains and benefits in their own operations. In order for the actors to realize these benefits there must be a framework in place to measure the relevant cost and benefits associated with the investment. (Svavarsson 2002) Lack of any quantitative study by an objective party on Return on Investment (ROI) has made it difficult to justify cost/benefit.

Although there have been some initial efforts to study ROI, there are no valid results available today to spur industry stakeholders towards faster adoption. As it can be also observed from Figure 7, there are some benefits that are obvious such as improved communication, reduced printing, mailing, faxing costs, and reduced RFI and submittal turnaround time. However, the users are less confident that they will enjoy the benefits of reduced claims and litigation costs, increased competitive advantage or reduced change order costs.

Figure 7: Realized benefits of OCPM tools according to the users

There is a need to complete an analysis on cost/benefit of this technology to measure and prove the value of these tools. A rigorous benchmarking exercise is needed to prove that these tools bring increased efficiency to the entire process of making buildings to hasten the adoption of OCPM tools.

CONCLUSION

“Critical Enhancement Areas” help to reinforce the need for further research and development of OCPM systems in order to achieve wider adoption by the AEC industry. Although there are valuable enhancements that can be made to technology, the most important problems are still organizational. (Callaghan 2002) The organizational issues surrounding the use (who is in control) as well as the psychology involved in getting all participants in projects to accept using new technology are now in focus. (Björk 2003) The current slow economic climate in the AEC industry is certainly contributing to retarding adoption but the largest factor lies in the culture of dynamics in the industry itself.

Unlike the manufacturing industry, where there is a centralized concentration of power and influence on the supply chain by the leading companies, the AEC industry is more fluid, and project based. Relationships are more temporary and consultative in nature. In addition, the industry consists of many players with different organizational cultures and objectives. There are liability and power issues, which engender scepticism and limit the use of technology to little more than creating electronic paper. As cultural barriers are slowly broken down, the industry will realize that OCPM technology is not driving revolution, but evolution, and the adoption will increase.

However, the technology providers should carefully listen to their customers to drive additional features and functions as well as enable better usability. Building on these values will keep the industry moving forward to drive better communication, increased productivity, and higher quality in buildings.

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