Web-based Document Management Systems in the Construction Industry

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SUMMARY

Construction industry has always been described as a fragmented industry (Latham, 1994; Egan, 1998; Tang, 2001) Communication amongst project team members is suggested to be improved. Web-based document Management system is adopted to ease of communication, storage and retrieval of information and improve the efficiency of work particularly for the fragmented construction. The improvement in communication, as a result, will improve the time, cost and quality of work in the construction industry. (Bjork 2003) This study investigates the current problems in the construction market, particularly on the communication and flow of information.

Fryer (1997) has commented that information management is making a major impact on planning, decision making and control. With the advancement in information technology and the widespread usage of the internet, web-based document management systems have been developed to maintain construction information. Further to the advancement in document management systems, collaboration technologies are then developed to provide further tools in communication for project team members.

With the adoption of these collaboration technologies, studies have been conducted to measure the efficiencies by adopting these systems. Similar to any information technology system implementation, there are obstacles in implementation and barriers to use in these collaboration technologies and, furthermore, room to improve.

This study concludes the findings of the study with recommendation to enhance the efficiency in the communication in the construction industry in Hong Kong, monitoring the flow of information and wider adoption of collaboration systems by construction industry practitioners in Hong Kong are made. It will also examine the role of software developers to further improve their systems in order to achieve wider adoption of collaboration systems in the industry by changing certain perspectives of the industry practitioners who are not currently utilizing these systems.

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Web-based Document Management Systems in the Construction Industry

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1: Introduction
1.1 Background

The construction industry has always been described as a highly fragmented with an ingrained adversarial culture, in the sense that individual participants each pursuing his singular interests on a project-by-project basis and the communication between its participants has lead to inefficiencies. Two of the earliest industry reports to document the need for change are linked to studies done by the Tavistock Institute of Human Relations (Higgins & Jessop 1965). In recent years, Latham (1994) and Egan (1998) in the United Kingdom, the C21 (1999) report on the Singapore construction industry, and the Tang (2001) reports in Hong Kong, all of which have generated a considerable number of recommendations for improving the construction industry in their respective countries. Numerous reports and studies for example Latham, 1994; Egan, 1998; Tang, 2001, recognize the problem of fragmentation in the construction industry is not new and there is a need for improvement in the construction industry.

When proper methodology is not communicated properly to the workers on site, the safety of the project may be devastating. Latham (1994) also points out that these inefficiencies identified pointed to the need for greater partnering and collaboration in the Construction sector. Latham (1994) also explains that a poor project organisation -- a lack of attention to detail relating to project structure, communication, and execution -- can be singled out as a key factor in many cost over-run projects.

Egan (1998) comments that new technology can be a very useful tool in the design of buildings and their components, and in the exchange of design information throughout the construction team. Through better communication there are enormous benefits to be gained, in terms of eliminating waste and rework. However, Egan (1998) further recommends that technology on its own cannot provide the answer to the need for greater efficiency and quality in construction. Change in construction can benefit from the advancement in technology but first of all must by first sorting out the culture, then defining and improving processes and finally applying technology as a tool to support these cultural and process improvements.

Tang (2001) stated that the construction industry in Hong Kong is an information-intensive industry. In view of the participation of multiple parties during the project delivery process, effective communication within the project team is crucial for successful project implementation. "IT will help to improve construction efficiency through better information flow among project participants, improved design capability and enhanced project logistics management." (Tang, 2001) Tang further suggests that "a common data infrastructure to facilitate seamless electronic communication among industry participants" is desirable for

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improvement in the communication amongst construction practitioners. There are other research studies highlighting the problems of communication and information exchange in the construction industry for example Bjork (2003), Sommerville and Craig (2004), Wong (2008) Cross-discipline communication between professionals is very often problematic and is also a major contributing factor to the poor performance in the construction industry. (Sommerville and Craig, 2002a)

Can e-mail be a substitute for a electronic document management system? To date, almost everyone has access to e-mail, some people are attempting to use their e-mail systems to communicate design changes. Others believe that e-mail traffic can substitute for a dedicated electronic document management system. The ease of e-mail makes this a tempting proposition; however, communication is only one part of the story. Shipman (1998) states that communication without proper controls can actually make problems worse.

Large projects can generate large numbers of drawings and correspondence, shared between hundreds of participants in dozens of locations. Preliminary results carried out by Backblom and Bjork (2002) have indicated that the size of a project is a very important factor in determining whether or not a electronic document management system is used. "The Internet is changing the way business is done in construction. Despite the immaturity of the technology and its short history, e-Business initiatives are already transforming industries and becoming a key component. The Web has become a source for information, goods, and services, and a means of communication." (Issa et al. 2003)

In Hong Kong, there are a lot of international architectural and engineering consultant firms whom are working on projects world wide. Contractors, due to the relatively small scale of the local Hong Kong construction industry, are also working on a lot of international projects, i.e. Macau, China, Middle East, Malaysia, India, Vietnam, etc. When Hong Kong construction industry practitioners are answering the questionnaire or being interviewed on their perspectives on these electronic document management systems, their opinion are based on the projects they have worked on or working on. These projects range from small scale fit-out projects situation locally in Hong Kong as well as international projects situated outside Hong Kong involving multi-national project team members situated all over the world. This study is therefore aimed to review the perspectives of construction practitioners as a whole rather than a project by project case study.

In view of the different research studies conducted by various parties, this study will investigate the current usage of web-based electronic document management system by the Hong Kong construction practitioners and the overall comments for those who has used these systems as well as the perception from those who have never used these systems. This study aims to review the benefits of the implementation of these web-based document management systems and shortfall of as viewed by construction practitioners in Hong Kong. Based on their experience, this study will formulate possible suggestions for the future in the implementation as well as how the construction industry may improve in their communication in the future.

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1.2 Scope and objective of Study

The aim of this study is to investigate the benefits, shortfall, obstacles and acceptance of web-based document management system (collaboration technologies) by various parties in the construction industry.

There are a number of commercially developed web-based document management systems in the market that have been launched within the past few years that have been adopted on different projects in different countries. This study reviews the users' experience of using these software systems.

The detailed objectives of this study are:

1. To review previous research on the use of collaboration technologies in various industries in various countries.

2. To review previous research to identify the problems and benefits of adopting collaboration technologies in the construction industry.

3. To investigated the use of Collaboration Technologies for construction practitioners in Hong Kong past and present.

4. To make recommendation for the greater adoption of Collaboration Technologies by construction practitioners in HK.

2.0 Methodology and Approach

In order to achieve the objective of this study, literature review, questionnaire and interviews are conducted in order to review the effectiveness and acceptance of web-based document management system in the construction industry.

There are a few studies conducted around the world reviewing the benefits and short-falls in adopting the web-based document management system. These studies and conference proceedings are analyzed in details for their benefits and shortfalls. Data collected from questionnaire and interviews will be compared against these reports to analyze the differences in the perception in adopting these systems.

2.1 Definition and review

In the construction industry, even one single project of a small scale can generate numerous documents. The types of documents include, design drawings, specifications, contracts, request for information, architect's instruction, specification, variation order, shop drawings and other numerous correspondences.

Traditionally the construction process has been handled by breaking the process into separate parts due to its inherent complexity. Cooper et at (1997) comment "by breaking the construction process into smaller processes, it has successfully makes the process manageable, but it also has two disastrous effects: it extends the timescale and it impairs communication between the parties." Information generated during the construction process

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comes in different forms, from various parties of a project, and, is often extensive.

Automating document management is seen as a first step towards integration. Currently, one of the popular was the adoption of Electronic document management systems. It is most naïve to think that electronic document management systems can solve the communication problems within the project level though it will allow rapid and accurate exchange of information, speeding up project and allowing more flexibility to handle client's need for change.

Electronic document management systems evolved to where the system was able to manage any type of file format that could be stored on the network. The applications grew to encompass electronic documents, collaboration tools, security, and auditing capabilities. It is further explained by Bjork 2002 that Electronic document management systems focus on facilitating the management of documents pertinent to particular enterprises, projects and work groups in computer networks.

3.0 Advantages of adopting the collaboration technologies
3.1 Accountability and traceability

The ability of these systems acting as document management system, has no doubt, be most beneficial for the construction industry when information are enormous. Similarly, the "Better audit trail" and "Easier to find what you're looking for quickly" shared also very high score in the views of construction practitioners in Hong Kong. The systems enable the different parties to search for the information quickly with clear instruction and location. When an audit needs to be conducted, the traces can be retrieved quickly with automated functions within these systems.

Another confusion that has always caused delay in construction is the usage of wrong version of drawings. With the implementation of these systems, respondents have identified the significant benefits of "ensures everyone works from same version" and "less confusion over which version of is the current one"

3.2 Project Management and Communication

Sulankivi (2004) expresses the benefit of "the opportunity for more flexible planning of own time" is measured as a qualitative benefit. It is particularly important for design consultancy organizations where most of the designers and engineers might not be working on one particular project at the same time. The reduce traveling time for meetings and delivery will provide an opportunity for them to well plan their working hours and also their own free time. More and more projects these days are located internationally and design companies may be hired throughout the world to collaborate on a project. The top two benefits have shown the beauty of the web-based document management system has brought the world together to work as one. Designers located in different countries, contractors on site and designer at their own offices are not bound to their locality anymore. Information can be transferred easily and the dispersed teams can work far better together and less argument can be anticipated. Project information available in central location is another perceived benefit for the management of the project.

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3.3 Document Management, storage and retrieval

Respondents have generally find there is less chance in losing important document / records since most of the systems provides the traceability function when uploading and downloading can be monitored closely. Information is more secure is arguably another significant benefits identified by most of the respondents. In most of the recent research, security of web-based information is still in doubt; however, the information uploaded to these third party extranets will definitely provide better security than a simple network system in designer or contractor's own office or even on a Compact Disc.

The problem is that, with dozens of engineers working on thousands of drawings, there is no guarantee in this scenario that the drawing being sent is the latest approved version. There is no assurance that someone else hasn't already modified the same drawing. Also, there is no guarantee that the person sending the drawing is distributing it to all the people (or the most relevant people) that needs to know about the proposed changes.

To overcome this problem, the electronic document management system allows users to attach pointers to documents stored in the system, in the e-mail messages, instead of attaching the actual documents. This allows recipients to get the documents from the system, thus ensuring that they are using only the latest approved version.

3.4 Handover & Commissioning and operation and maintenance

It is identified that the key benefit is the accessibility of document throughout the day and there is no need to rely heavily on working hours and time zone differences. During the handover commissioning and operation period, most of the project team members are deployed to other project already and it is important that document s are more complete at hand-over and accessible easily. The results have shown a high significant level of confidence by most of the respondents on each of the benefits. In particular, the "Provides a more usable archive of facilities management information" is of particular research value when not much research has been conducted on the perceived benefits of electronic document management system on facilities management.

3.5 Perceived advantages of adopting the collaboration technologies

Those who have used these systems have identified they can rely on the system to store important document rather than the traditional paper-trace. Important document can easily be stored and tracked with the assistance of these new technologies. However, respondents who have never used these systems do not possess strong confidence or understanding in the security or successfulness in the storing of important documents on a web-based system.

3.6 Benefits associated in the design process

In compare with the UK report (NCCTP, 2006), the benefits identified by the Hong Kong construction industry practitioners in the questionnaires have a different perspective on the perceived benefits. Firstly, the percentage identifying substantial benefits are generally lower than those in the UK study. Secondly, the overall percentage of acknowledging these benefits is higher than those in the UK study. In particular, the ones identifying "few revisions needed" as benefits is 52% in HK compared with the UK study of 43%. In general, this

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comparison acknowledge that the HK construction practitioners are generally viewing the collaboration systems are beneficial to the design process.

3.7   Litigation support
As discussed in Shipman 1998, while everyone goes into a new project assuming that all will go well, the reality is that often problems occur during plant design and construction. These dilemmas can include unexpected problems at the site, design changes, changes in project scope, problems in obtaining permits, etc. Typically, these difficulties result in cost overruns and delays in plant operations. It is important that document traces are available for future references.

Most of the web-based document management systems contained the documentation's evolution history. This includes information about each document and its status including answers to the following questions:
- *Who created the document?*
- *What is the current revision level?*
- *Is the document currently checked out for modification?*
- *Which subsystems and assemblies are effected by the document?*
- *Who must approve any changes to this document? (Shipman 1998)*
- *When was the information submitted and uploaded*
- *When was the information retrieved by which person*

These traces of revisions, uploading and downloading record can provide a better understanding of who has done what in the system. When a contractor is claiming for extension of time due to lack of information, variation suggested by the design team, assessment of timing can be ascertained by the log of these traces.

When there is a major dispute in the project, these traces and logarithms can be evidence to be submitted to court as these document thread and traces are actually monitored by a third party service provider where these log are computer generated which cannot be easily modified by the project team members.

4.0   Obstacles
4.1   Technical Barriers
Respondents to questionnaires and interviews have similar hesitation when adopting these softwares for collaboration systems. They have identified the following problems:
- There are too many software in the market to choose from, and, the softwares are not compatible with each other. One consultancy firm might need to be using different systems in the same company while working on a large range of projects.
- It is not easy to make corrections, mark-ups and adding comments and annotations to electronic copies.
- Long term reliability of the service provider for their support might become a problem in the back up of information

4.2   Behavioural Barrier

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As discussed in numerous articles, construction is a fragmented industry and the practices are mainly depending on the norms. Respondents have identified the following behavioural barriers:

- In Hong Kong, IT literacy on site is observed as one of the problem in the industry in preventing the implementation of such tools. Furthermore, there is the refusal to change and adopt new technologies, particularly found on construction site where the workmanship is the key to their work rather than using computerized tools in their work.
- Poor systems might affect a users perspective on these technologies as a whole, as stated by one of the respondent who has used collaboration technology for only one project "Any software or system will receive its complains
- In one of the interviews, a respondent stated "It requires high degree of discipline and strict protocol must be in place and followed by users. I still like the good old days of Fax and filing in Box folder. It makes people think twice before any action.". This is an interesting observation by the respondents as people intend to send one sentence or even one word e-mails to answer simple questions. In the days when fax and letters are still widely used, everyone will spend time reviewing the questions and relevant document prior to answering and sending out the information. The advancement of technology has made it way too simple for semi-educated answers. The degree of discipline and strict protocol as suggested by the respondent can be set up by the system administrator who can monitor the relevant access criteria and level of information to be obtained by each of the users in the system.

4.3 Cost-related barriers

- Some of the systems were found to be relatively user-unfriendly and users were asked to attend full day or even 2-days training workshops to be familiar with the usage. However, the ever changing nature of the construction industry has found these training exhaustive as the systems might change from time to time. Even though users are given training, difficulties in navigating are not uncommon. The lost of man-hours in these training and the time required to be familiar with the
- As construction projects are unique by nature, team members varies from project to project. Recently, mega size projects are naming collaboration systems as part of the requirement in the tender document. Designers and project managers are choosing the cheapest possible system in order to be competitive in the bidding. Moreover, respondents working in developers expressed that the cost of implementing these systems will increase the overall construction cost of the end product.

4.4 Organisational Barriers

- Amongst all the responses from questionnaires and interviews, there is almost a common question: there are so many different softwares in the industry, who should be the one to decide on which brand to use?
- Approval time and time awaiting feedback for drawings is always a concern for fast-track projects in Hong Kong. One of the respondents has stated that the efficiency of these softwares on drawing approval can hardly be justified.

4.5 Legal Barriers

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- Although most of these systems have included an authorized username and a password as a security measure, but this may not be sufficient to control confidential information. The publicized information on the document management system will need an advanced user to control the viewing, editing, deleting capability of individual users. Different level of access should be set up carefully in order to secure certain confidential information, e.g. one tenderer will not be able to see who are their competitors, fee proposals or correspondences with the client from the consultants should not be viewed by the contractors, etc.
- There are obviously obstacles in the construction industry to adopt a paperless environment as drawings are large in scale and cannot be easily viewed on one single screen. Construction workers are not proficient in IT system and applications which makes digitized drawings and approvals not utilized to its full extent.
- When different parties in a project are having disputes on project information, it is arguable that the project information on the system can be reliable as the legal trace of information when they are going through arbitration or litigation.

5 Conclusions and Recommendation
5.1 Government Assistant and initiatives
To encourage research activities, use of innovative techniques and the establishment of standards for the industry. However, research activities have not been satisfactory. Limited research has been conducted other than the ones initiated by private sectors, i.e. service providers on the adoption of new tools and technique in the construction industry. The promotion for use of innovative techniques, in particular, the adoption of collaborative technologies, by the government has not been seen at all. To promote the use of these systems, the government is suggested provide subsidies for companies taking these initiatives and award could be given to those successful projects who can fully adopt these systems.

The government bodies should work with the construction industry for a standardize set of information and coding system. This will bring forward a number of benefits further to Wong (2008). If there is a standard coding system established, once a construction industry practitioner is trained, he need not be trained again using another system. Furthermore, the standards and codes can also be part of the university curriculum for engineering, architectural and surveying degrees. The cost of training for systems can be reduced as university graduates already possess the knowledge. If the government took the initiatives and discuss with the service providers, pilot projects can be set up to adopt these systems. When a project adopting these collaboration systems has completed, benefits can be measured and it will soon become a industry norm if the benefits are seen to be enormous. Private companies are still watching how the others are working out with these collaboration systems. If the government starts to adopt by setting up pilot projects, the construction industry will investigate further into adopting such systems.

5.2 Exchangeable information
Most of the respondents have used more than one kind of these systems and these systems cannot talk to one other. If one project uses one system and most of the information can be re-used on another project but the project adopts a different system, all the information will

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need to be downloaded and re-uploaded to the new software. In view of all the responses both in the questionnaire and interviews, there are numerous complaints in the time required to learn different systems as well as the systems' compatibility. As there are a lot of service providers currently in the market, it is recommended for commercial software companies could look into developing a system that would allow different technologies to talk to each other. It is not a simple task as companies have different incentives and competitiveness in their own information technology industry. In addition, different systems have their own strengths and weaknesses, which make it difficult for companies to make the choice.

There are also researches suggesting an international coding and standardization of information should be reached and published (Wong, 2008). It is recommended that the system vendors will investigate in the exchangeable of information between systems. The exchangeable information will ease out certain barrier and obstacles in implementing collaboration systems, particularly the training on the system coding. Cost of training has been flagged as a barrier to adopt these systems by different respondents as well as in the questionnaires received. If the system coding, platform are similar and exchangeable, construction related companies. i.e. developers, design consultants, contractors will be more willing to adopt these technologies as the investment will not be easily depreciated over time.

5.3 The advancement of technology over time

Technology has been changing in such a rapid mode in these years which makes the construction fairly difficult to catch up with. Twenty years ago, not many people possess a mobile phone or a computer at home. To date the usage of personal computers is almost a must at every household and everyone is carrying a mobile phone. However, on the construction site, the major advancement on technologies is mainly on the machinery and tools. Simple computers are installed in the site office for drafting purposes and word processing. Information technology is not utilized on construction site at all and it is rather difficult to fully benefit from the benefits as described in previous sections. In order to have better communication and advancement in construction technology, the author would like the contractors to take immediate steps to improve their adoption of Information technology on construction site. This would bring not only easy access of information but also possibility in reducing their overhead cost as well as shorten the time period required in the construction period.

In a recent report by the Department of Energy in the United Stated (2007), there is a recommendation on the continuous measure of the benefits for these communication technologies in the construction industry and its readiness prior to adaptation. It is also important to develop comprehensive standards for systematically measuring and communicating the readiness of project technologies. There is no doubt that the collaboration technologies are improving the communication within the construction industry which, consequentially bring forward the benefits of better time saving, improving quality and cost savings. The benefits are to be measured systematically and continuous measurement by institutional research, private sector measurement and government initiatives will continue to improve the implementation of these systems at large.

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5.4 Contingency plans for system shortfall

Any technology would have its shortfall or downtime. Every system might have its own bugs, problems or loopholes. Organisations or projects adopting the electronic document management systems or collaboration systems should set-up contingency plans for system malfunction. Every minute in the construction project cost manpower and money. Projects cannot take the risk of not being able to access the project information. Project teams should have its project plan and manual for the quality assurance, contingency plan for system failure and should be clearly established in the manual such that people will know what to do. Suggestion for the contingency plan will be off-line system back-up, a daily system back-up is quite normal but it will incur additional storage space for computer servers. It is also recommended that companies should look into systems that can work both on-line and off-line, most of the time

5.5 Change of industry attitude and practitioners' behavior

As discussed in previous chapter of the study, there are barriers in adopting these electronic collaboration technologies because of human behaviour and their resistance to change. In particular, as addressed in the interviews, the advancement of e-mail and too easy communication, everyone will not spend sufficient time reviewing the questions and relevant document prior to answering and sending out the information. The advancement of technology has made its way too simple for semi-educated answers. The degree of discipline and strict protocol as suggested by the respondent can be set up by the system administrator who can monitor the relevant access criteria and level of information to be obtained by each of the users in the system. Furthermore, a time delay for a few minutes on the e-mail and alerts can also facilitate the concern over semi-educated when the users have sufficient time to retrieve the documents if they are not meant to be issued.

The construction industry is urged to change their attitude towards the adoption of information technology, particularly on construction site. This collaborative approach allows informed decision making early in the project where the most value can be created. The close collaboration eliminates a great deal of waste in the design, and allows data sharing directly between the design and construction team eliminating a large barrier to increased productivity in construction.

It is also important to note that the resistant to change is normally top-down. It is usually the middle management who is tasked to find ways to enhance the time, cost and quality of a construction project. He then investigates the use of collaboration technologies and suggested to the top management. Normally senior management of companies relies heavily on their secretaries or administrative staff to deal with these systems. Without personally experiencing the well-being and advantages of these systems, it is rather difficult to urge them to invest a good some of money from their profits. This will become the first hurdle in the implementation of collaboration systems as a whole. If no one is going to invest in purchasing, how can the construction industry implement the systems? Even if the companies have decided to invest, they need to take serious step from their top management to ensure the benefits of adopting these systems are carefully communicated to their staff as well as other project team members.

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5.6 Project owner – Project 'champion"

In order to properly implement a collaboration system, whilst facing a lot of resistant from the construction industry, it is recommended to identify a project champion who will oversee the well-being of the implementation. It is suggested by Bjork (2003), it is beneficial "that having a technology Champion' – a person who knows the technology and is familiar with its benefits, can be vital to get other participants in the project to adopt the technology. It is also noted in Becerik and Pollalis (2006) and Castle (1999) that successful implementations need identification of an application sponsor, a champion, on a team and definition of the processes and procedures for the project. Contractually mandate the training and the use of these systems will be another tactical step towards implementation of these systems. In Hong Kong, the identification of a project champion is not normal as it is the Chinese Tradition that everyone will only take care of its own business. Taking leadership in this kind of system implementation might be seen as overtaking all the responsibilities for the failure. The industry is recommended to try and adopt a different attitude in the way they implement new systems. The identification of project champions has been proved successful in numerous research studies particularly for the implementation of information technology systems.

5.7 Which system?

We understand from interviews that different developers, design consultancies and contractors have signed agreement with service providers to provide collaboration systems for their projects as a whole. However, when a developer decides to adopt a system that the architectural consultancy has an agreement with, additional usage license may be required. It will then add extra cost to the project for the implementation to these systems while the architectural consultancy might have paid for a nominal fixed sum for their own usage already. The author would suggest construction professionals and practitioners to investigate possibilities with service providers of collaboration technologies when discussing contractual relationship and terms in providing blanket usage license allowing other firms on the project to adopt the systems within paying extra fees. The limitation on the license and authorized users on a project might need to be negotiated with the service providers as each extra copy of the collaboration systems or an extra username will cost extra.

5.8 Courses in universities

Young professionals are the most adaptive ones for advancement in technologies and the most willing to try new systems. It is suggested to start them with the collaboration technologies with the benefits and usage since university such that they are very familiar with these systems when they start to practice in the construction industry.

Information technology course and training should be made compulsory for site office staff to ensure they are familiar with the systems the project team is to adopt. It is essential to get the project team members to buy-in into the adoption and implementation throughout the project life cycle. In order to achieve the buy-in from members, the client, or the one making the final choice of which system to adopt, should consult the project team members to send representatives to product training and or presentation for them to realize the benefits of using it. In addition, partnering working and partnering charter is another method in getting the

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construction practitioners to realize their involvement on the project and how they should work with the project team members. Information technology and implementation of collaboration systems should become part of the partnering process as early as the project inception stage for a smooth implementation process.

5.9 Further research

Construction practitioners in Hong Kong are not confident with the benefits brought forward by the collaboration systems with all the barrier and obstacles in mind. Further measurement and research on the benefits, particularly on the counterbalance on the cost and time saving against the cost of investing in the technology is suggested.

In the conclusion of Andresen et al (2000), measuring the benefits of IT innovation has always proved difficult and it should be considered as a portfolio of benefits distributed across several organizations. Further research on the portfolio of benefits for the adoption of collaboration technologies is suggested in order to bring the construction industry forward to the next step in information technology.

6 Conclusion

This study covers some of the researches on the electronic document management system and collaboration technologies currently available. The efficiencies of these systems have been examined and it is clear that these systems will enhance the communication with the project team in the construction industry. The enhance communication, will lead to time saving, better quality of work and cost savings.

Data collected from questionnaires and interviews have shown that construction practitioners in Hong Kong are starting to adopt the new systems with only limited experience on these collaboration technologies. The efficiencies might not be as easy to be realized by the industry at this early stage of adoption. Further research on this topic is strongly recommended to continuously measure the benefits obtained by implementing new information technology to the construction industry in Hong Kong.

The Hong Kong Government is recommended to offer assistance to the industry for the implementation of these systems in order to achieve the recommendations in the "Construct for Excellence" report (Tang, 2001). The assistance to the industry can be in the form of subsidies to purchase software license or provide vocational training to construction site personnel at a nominal course fees. Similar to the US and Finland government, guidelines should be established for enterprises to select the appropriate systems as well as the standardization of the codes and systems are initiations to be undertaken by the Government.

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BIOGRAPHICAL NOTES

Tzena Wong is a qualified quantity surveyor/project manager practicing in Hong Kong. Having a bachelor degree in Asian American Studies / Sociology, she has a different perspective in the industry whilst joining from a completely different background. She has also completed her Master of Science majoring in Construction Project Management in The University of Hong Kong. Tzena has gained vast experience in managing international projects with multinational consultants and contractors. She is currently working as a senior associate in an international architectural practice. With her training in Europe, US and Asia and supplemented by background of different language skills, she has seen communication in the construction industry as the key to successful projects. Tzena was awarded the Young Surveyors Award in 2011 by the Hong Kong Institute of Surveyors.

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