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INDUSTRY PERSPECTIVES ON THE IMPACT OF IT AND E-COMMERCE

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ABSTRACT

In recent years several new IT-based technologies such as e-commerce have been developed, which if applied to the construction industry can prove beneficial. Before the implementation of new technologies and applications, it is essential to identify the factors that the industry perceives as being the enablers and barriers to the uptake of these applications for greater effectiveness. This paper presents the results of a survey undertaken to establish the views of industry practitioners on the uptake of IT (and e-commerce in particular) within the UK construction sector. The survey explored attitudes, current usage, barriers and enablers amongst other things. The findings of the survey are briefly discussed and outline ideas for more effective deployment of IT and e-commerce in construction organisations presented. The paper also tries to outline some future prospects for using e-commerce in the UK construction industry, based on responses to the survey.

KEYWORDS

Information Technology, E-commerce, Construction Innovation, UK Construction, E-commerce Barriers and Enablers

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INTRODUCTION

It has been well documented that the construction industry is characterised as being both fragmented (Anumba and Evbuomwan, 1999; Egan, 1998; Lottaz et. al., 2000) and information-intensive (Thomas *et. al.*, 2001). A considerable degree of information flows between disciplines including client, architect, structural designer, quantity surveyor, services engineer, fabricator, subcontractors, contractor and material suppliers. A construction project is a team effort, which involves several inter-organisational activities, dialogues and data flows, making it a highly complex process (Egan, 1998). Currently, the information flow in the construction industry is mostly paper-based and hence slow. Also there is the likelihood that there will be increasing amount of communication blockages as the projects grow larger and more complex (Thomas *et. al.*, 2001). Conventional paper-based methods of communicating information are grossly inadequate particularly in collaborative/concurrent engineering settings where the project team members may be geographically distributed. It is therefore very important for construction project teams to look at alternative and more effective ways of communicating through the project lifecycle. Construction projects can incur considerable savings in terms of time and money by adopting dynamic methods of information exchange and communication facilitated by IT and e-commerce tools. The exponential growth of the Internet and the growing use of IT have accelerated the pace of change, and demand more flexible and adaptive organizations (Malone and Crowston, 1991). Construction organisations that decide to enhance their business processes using IT and the Internet should recognise that adopting such 'innovative' methods will facilitate in integration of the entire management process for construction projects. The flow of information in such a system will be electronic and hence interactive. It will make use of the Internet as a 'medium' for data storage, data transfer, communication, conferencing, dialogue and decision-making and acquiring information. All these tasks would be carried out in a monitored and secure environment.

With developments in IT, the construction industry is adopting new and innovative tools to overcome the current inefficiencies in its project processes; these are mainly through facilities for exchanging and organizing project information (Lottaz et. al, 2000). A survey of the UK construction industry, undertaken by the Construction Products Association (CPA, 2000), predicted that by 2005, 50% of the industry's business activity would be undertaken using e-commerce. However, another survey carried out a year later by the same organisation (CPA, 2001) indicated a considerable reduction in these projected figures to 22%. The construction industry stepping back from the initial 'dotcom fever' was seen as the main reason of this change. This paper presents selected results from a 2001 survey on Information Technology and E-commerce in Construction that was carried out to establish the current usage of IT and e-commerce in the UK construction sector. This survey has been carried out as a part of a broader research project on 'Business Process Implications of E-commerce in Construction' at Loughborough University. The primary objectives of the survey were:

- To establish the readiness of UK construction industry to adopt IT and, in particular, e-commerce technologies and;
- To identify the barriers and enablers to the implementation of these technologies in the day-to-day construction processes.

The paper gives background information about the survey questionnaire and objectively analyses the results using illustrative charts and statistical data as appropriate. Finally, the paper discusses the future prospects for using e-commerce in UK construction, based on the survey results.

SURVEY BACKGROUND AND METHODOLOGY

Several surveys have been conducted in the past couple of years to determine the impact of IT in the construction industry worldwide (Rivard, 2000). In the UK surveys have been conducted to gauge IT usage within the construction sector by DETR in 1999 and by the CPA in 2000 and 2001. The data used in the DETR survey is already three years old, while the CPA survey concentrated on e-commerce transactions within the construction supply chain, and particularly with respect to construction product suppliers. The survey conducted by the authors mainly focuses on the uptake of e-commerce and IT within the construction industry and identifies the main barriers and enablers. It is vital that the barriers, enablers and the potential of using technologies such as e-commerce are identified, examined and analysed in order to make recommendations for an effective uptake of these technologies within the construction industry. The findings of this survey will be used as one of the sources to formulate an effective strategy for development and uptake of new e-commerce applications in the construction sector. In order to benefit fully from such technologies will require changes to the existing business processes (Howard and Andresen, 2000). This is one of the key objectives of the research project that looks into reengineering the current construction business processes with particular focus on suppliers and end users.

The survey was carried out in the first half of 2001. The questionnaire occupied four sides of A4 paper. Paper copies of the survey questionnaire were distributed by post to a random sample of 145 construction organisations encompassing various construction disciplines including architects, engineers, contractors, manufacturers and suppliers within the UK. Each respondent was given the opportunity to respond anonymously, however, a high percentage of all the respondents provided contact details to receive a copy of the survey results. The findings presented in this paper are based on an overall response rate of 22%.

SURVEY ANALYSIS AND RESULTS

Selected results from the survey are presented in this paper and include computer usage (hardware and software), communication networks (inter and intra-disciplinary levels), information technology, and e-commerce technology within the UK construction sector.

COMPUTER USAGE

This section considers the level of computer usage and includes the use of different types of operating systems, office software applications and specialist applications performing specific business operations. The survey results indicate that the type of operating system used varies from company to company, with the Microsoft Windows being the most commonly used.

Effective communication is key to the success of any construction project. It has been well documented that a wide array of communication problems, ranging from delays to distortion of messages, can impose strains on overall construction project management

and project performance. The prohibitive costs of making long distance calls, facsimile transmission etc, have made the project management community in construction look for more viable alternatives (Alshawhi and Ingirige, 2002). The survey results have shown that the use of e-mail as a mode of communication is common and almost all companies surveyed use e-mail. Continuing the trend of dominant usage of Microsoft applications, it is seen that MS Outlook (73%) is the most commonly used e-mail application.

There are several specialist project management software applications available in the market and the survey results show that a high percentage of responding companies use project management software applications to manage projects. 53% of the respondents use MS Project as a project-planning tool while 27% used Primavera (www.primavera.com). Other planning tools PowerProject (www.astadev.de) and SureTrak (www.primavera.com/products/sure). are also used.

The survey also investigated the types of database systems used in the industry and the results suggest that the use of these systems is relatively common amongst participant construction organisations. The use of MS Access (65%) is higher than that of other database systems such as Lotus Approach (5%), dBase (5%) and SQL (15%). The remaining 10% use other database programs (e.g. Oracle).

The main output of any architectural and engineering firms is drawings and these drawings are now mostly generated using computers (Rivard, 2000). The survey results indicate that CAD (Computer Aided Drafting) packages are widely used throughout the industry. While 100 % of the architects use CAD packages for design drawings, the average percentage of CAD usage in the industry (including manufacturers and contractors) is 87%. CAD in this context refers to 2D(two-dimensional) CAD drawings.

COMMUNICATION NETWORKS FOR CONSTRUCTION

The efficiency with which information is communicated between different project partners of a construction project will depend on the communication systems that are being used by each individual organisation involved in the project. The survey tried to establish the percentage usage of different communication media including mobile phones, personal email, pagers and Internet, amongst office and on-site construction staff. Amongst construction companies, over 65% of *office staff* are connected to the Internet and over 85% have access to e-mail (see Figure 1). In contrast, only 40% of *site staff* has e-mail access. The use of mobile phones is twice as high for on-site staff (approx. 60%), as for office staff. This suggests that there is a high percentage of use of communication media within UK construction supply chain.

In recent years an increasing number of companies make use of the Internet to advertise and market their products and services (Ruikar, 2001). The survey results confirm this trend and figures show that 90% of the responding companies have company Web sites that advertise the company's products and services.

Intra-disciplinary mode of document exchange in construction organisations: Any construction project involves the production and exchange of a large number of documents and drawings at both inter- and intra- organisational level. A high percentage (73%) of the respondents said that e-mail is the most popular medium for the exchange of documents internally within their organisation (see Figure 2), while FTP (File Transfer Protocol) is the least likely. It can be seen that the method for exchange of documents/drawings internally, largely depends on the size of the organisation itself.

While larger organisations use e-mail as the preferred choice, SME's (Small to Medium-sized Enterprises) exchange documents by hand.

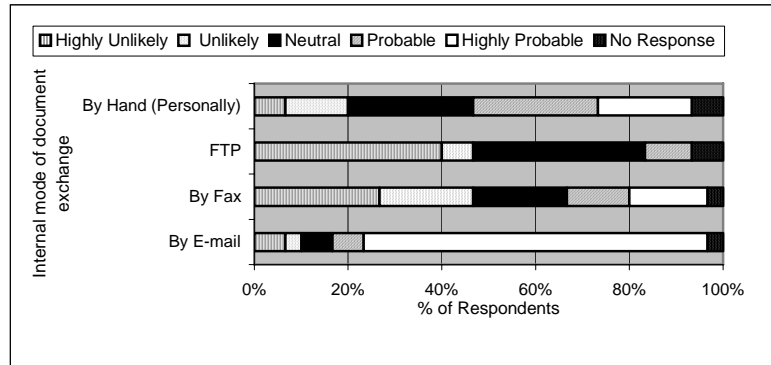


Figure 2. Mode of Document Exchange Internally Within an Organisation

Interdisciplinary mode of document exchange: The survey findings show that e-mail, fax and post are the most popular methods of exchanging information between construction disciplines. However, the most preferred method of communication could not be conclusively derived from these results. This could be because; depending on the document type, the preferred medium for inter-disciplinary document exchange may vary. For example, most companies' exchange documents such as specifications and project drawings electronically, while the exchange of documents such as Bills of Quantities and technical calculations is seldom done in an electronic format.

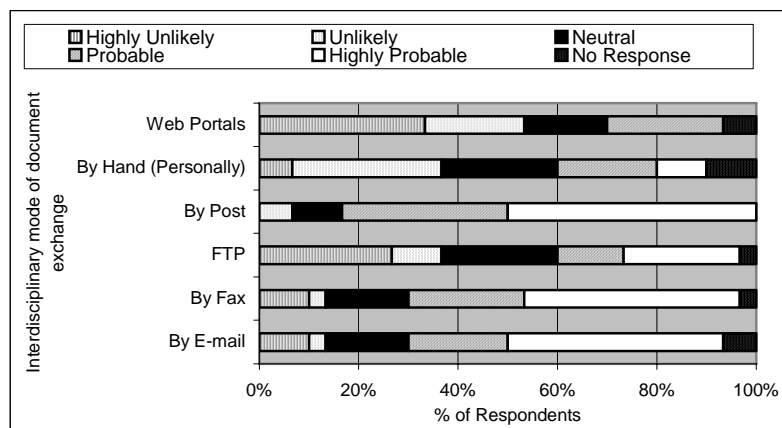


Figure 3. Interdisciplinary Mode of Document Exchange

ROLE OF IT WITHIN CONSTRUCTION COMPANIES

The main focus of this part of the survey was to examine the role of IT within the surveyed construction organisations and to establish the impact of IT on the organisation's day-to-day activities. Of the surveyed organisations it can be seen that 73% of architectural and engineering firms have a dedicated IT department and a

definitive IT policy. It is evident that majority of the responding contracting companies, have IT managers, but no well-defined IT policy.

The successful introduction of any new technology depends upon the receptivity of the staff (Rivard, 2000). The results have shown that the overall attitude towards the implementation of IT is generally positive. In order to establish the attitude of construction disciplines towards implementing IT measures, it was necessary to examine the most common factors that influence investments in this area. The need to improve the efficiency of office administrative work and demands from clients, are rated as the two most likely factors influencing IT investments. Additionally, a high proportion of the respondents (60%) also rate the need to be at the forefront of technical innovation, and demands from staff/employees as factors influencing IT investments. Some contracting organisations are hesitant to invest in IT and even suggested that their company would only be pushed into making IT investments, only if it is a client requirement or they can see quantifiable gains from it, in terms of improved business processes.

The survey questionnaire also tried to establish the extent to which the use of IT can improve the design or construction processes. Figure 4 shows the viewpoint of the respondents regarding the influence of IT in areas such as document quality, document errors, speed of work, interdisciplinary communication and construction business processes. More than 80% of the respondents regard increased speed of work, and improved interdisciplinary communications as the key influences of IT on design and construction processes. The response suggests that IT is currently being used to facilitate faster distribution of construction information. Every time data is re-keyed, it can become a potential source of error. Also each time data is transferred from one document to another, or entered into an electronic repository, there is a good probability that errors will be introduced into the data (Sharda, 2000). Some research studies suggest that businesses can eliminate errors that are caused due to data re-entry using technology tools (Watson & Anumba, 1991; Anumba, 1996); however, from the survey findings there is little evidence to suggest that the use of IT can reduce construction errors.

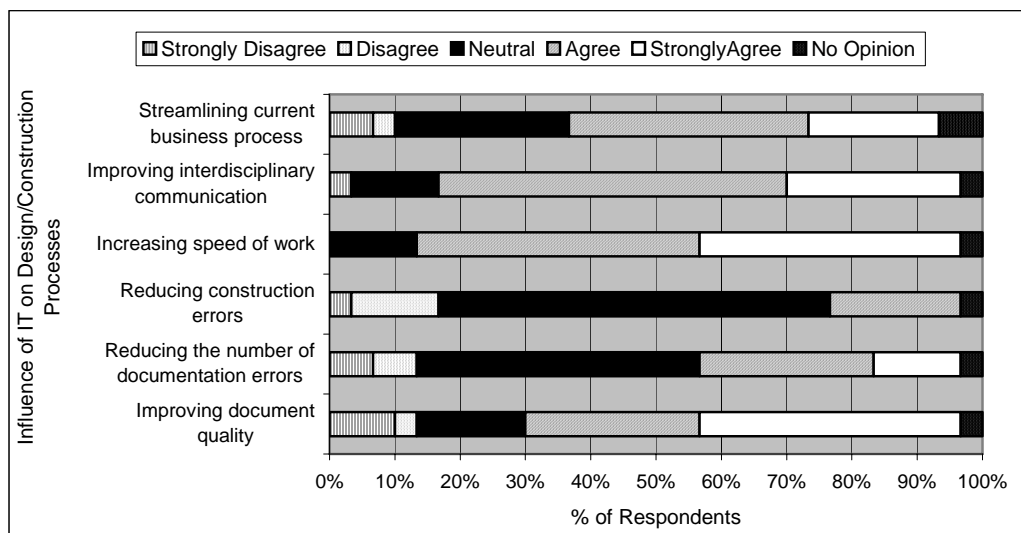


Figure 4. Influence of IT on Design and Construction Processes

Members of the construction industry need a sound understanding of the potential of advanced IT systems in construction if they are to gain business benefits from their use (Construct IT, 1996). From the survey results, it is possible to establish the key areas in which productivity has increased because of IT use among the participating companies. By productivity the authors mean an increase in the throughput. When asked whether the introduction of IT has lowered or increased productivity in areas such as company administration, project management and coordination, design and site management and interdisciplinary communication, 93% of the respondents said that efficiency in the area of company administration has increased (see Figure 5). The responses also suggest that areas of management such as site management have shown little change in productivity due to IT implementation (67% of contractors reported either very little change or no change).

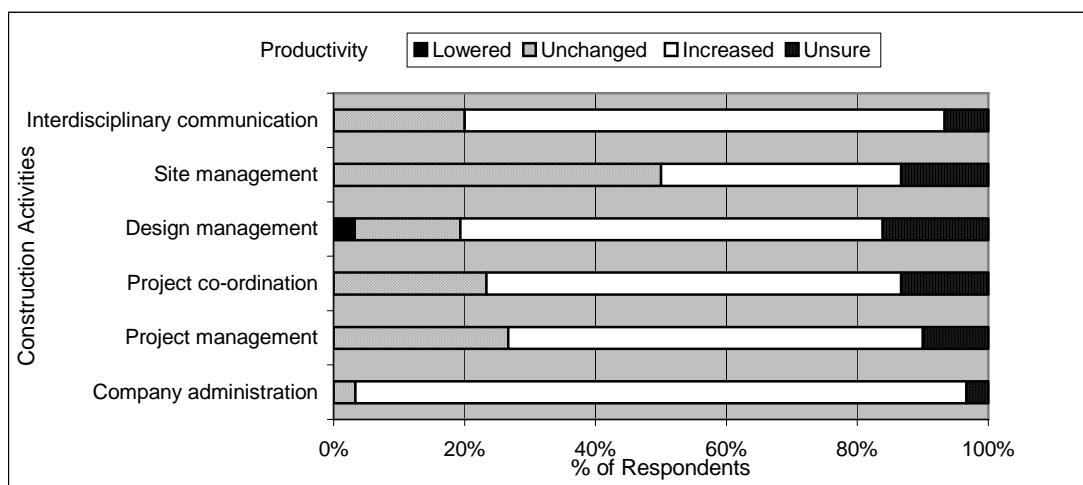


Figure 5. Influence of IT on Productivity

To establish in which areas future IT investments are most likely, respondents were asked to prioritise the possible IT areas in which their respective organisations are planning to invest within the next two years. Among the possible six choices included (see Figure 6), investment in CAD (Computer Aided Design) applications has the highest priority rating. Web collaboration portals, design and document management tools are also amongst the most popular IT systems for future investments, while investment in Virtual Reality (VR) applications has been given the least priority. Previous research studies in the area of VR state that the requirements of specialist skills, dedicated staff, cost of implementation and lack of integration between application packages (e.g. integration between CAD and VR software), are the major barriers to the implementation of Virtual Reality systems in construction (Issa, 2002); the industry needs to take these issues on board to encourage wider usage.

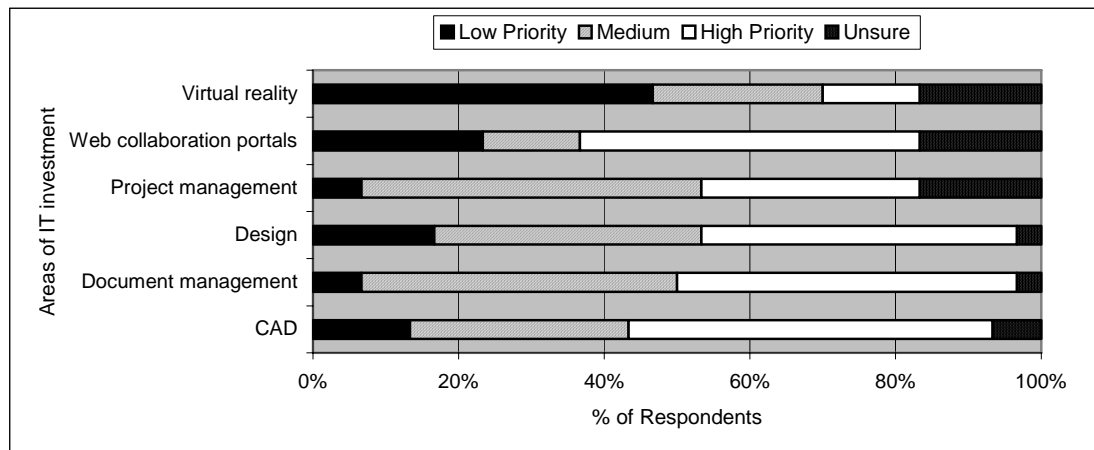


Figure 6. Future Investments in IT

In order to take on board new technologies it is vital that the benefits of and barriers to the use of these technologies are carefully examined and analysed. A majority of the respondents consider the use of IT applications to be beneficial for different tasks in the construction process (see Figure 7). In the view of more than 50 % of respondents, use of IT has helped in improving interdisciplinary communications and financial control, speeded up work and increased the possibility of sharing information. Implementing IT to facilitate better management of project data/documents and streamlining the business process are also seen as benefits. A report by the UK Task Force (Egan, 1998) has stated that technology alone cannot provide the answer to the need for improved efficiency and quality in construction. The survey results support this, as more than 60% of respondents do not agree that the use of IT can improve the quality of work.

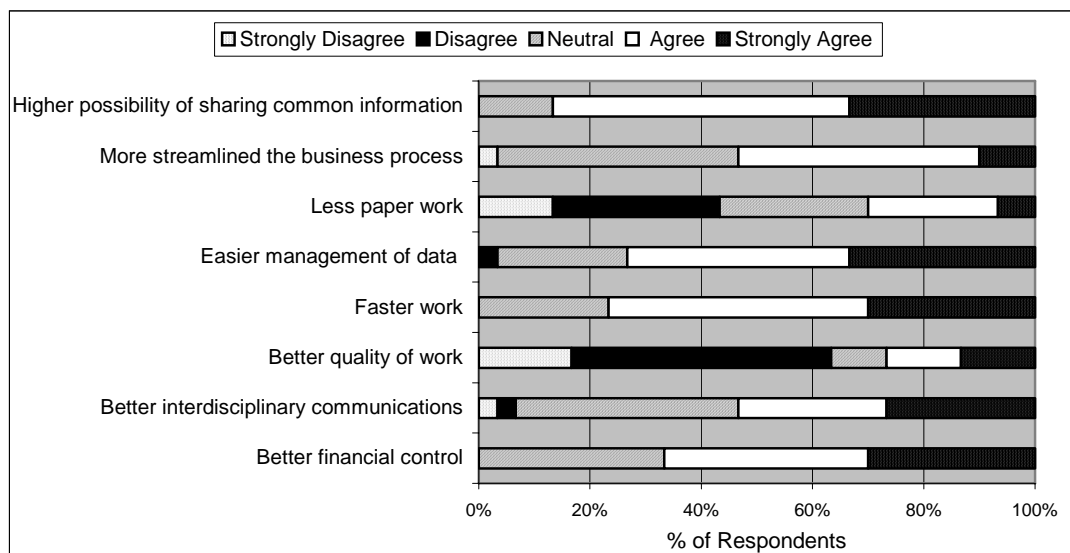


Figure 7. Possible Benefits of Implementing IT Measures

To establish the barriers to the implementation of IT measures, the respondents were asked to rank the barriers, which in their view are preventing wider implementation of IT within the construction sector. Barriers listed in the questionnaire were collated after a thorough literature review carried out by the authors (Ruikar, 2001). The respondents were invited to suggest/specify additional barriers. The results suggest that factors such as high cost of initial investment, lack of commitment from management in implementing IT and a lack of interest from company decision makers, are seen as the main barriers to IT implementation. Also, the low profit margin of construction companies is regarded as a barrier to the adoption of IT tools. Majority of respondents do not regard IT-related security issues, regular upgrades of software or hardware, and possible information overload as major barriers. The following section explores the uptake of e-commerce applications in the construction sector, the associated benefits and barriers.

E-COMMERCE IN CONSTRUCTION

By establishing the extent to which the Internet has influenced the construction industry and examining areas in which e-commerce is currently being used, it is possible to gauge the industry's changing attitude towards using technology. The section on computer usage in construction companies has shown that a high percentage of staff has access to e-mail. Also, the most common use of the Internet is for the exchange of information using e-mail services (Figure 8).

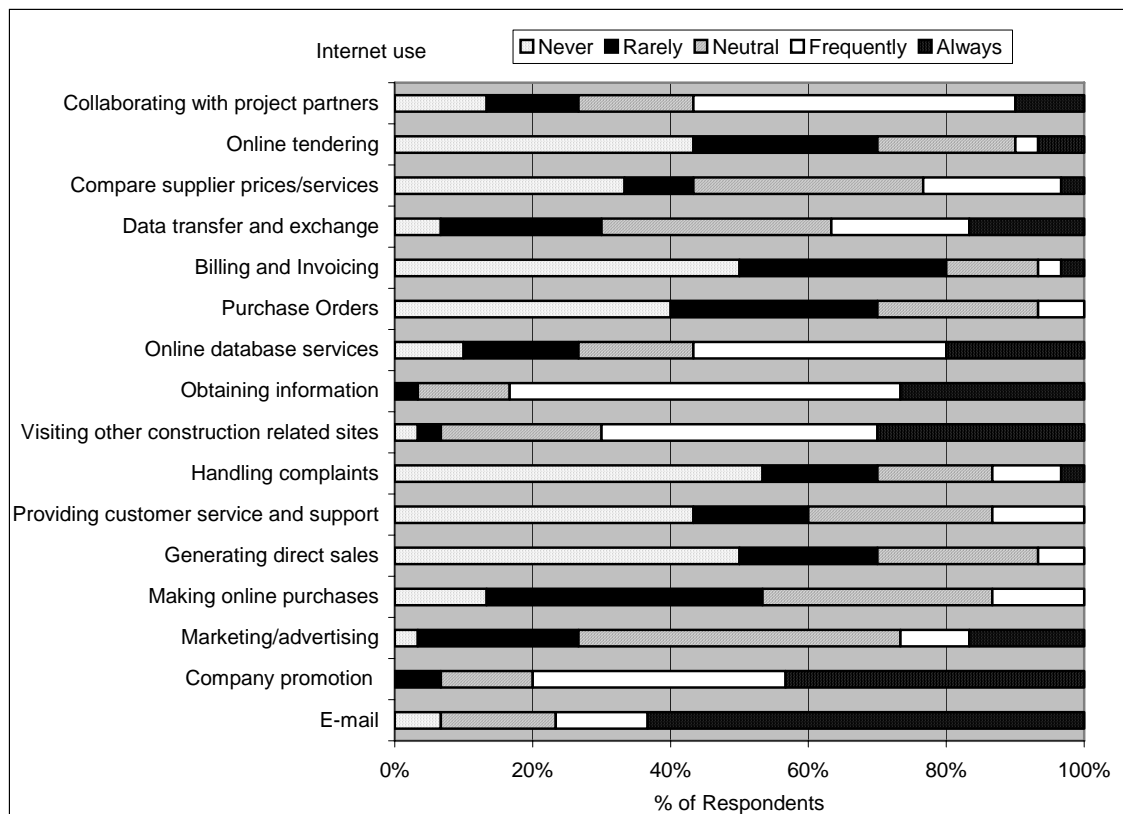


Figure 8. Use of Internet in Construction

The Internet is an efficient medium to promote a company's products and services. A majority of the companies (80%) have a dedicated company Web Site and use the Internet for company promotion. The survey outcome also suggests the Internet is being widely used for retrieval of construction-related information. About 50% of the respondents also use Web-based collaboration tools. An interesting observation is that a high percentage of the responding manufacturing companies do not use the Internet for strategic activities, such as customer relationship management (CRM). Also, very few firms use the Internet for financial transactions such as billing and invoicing (6%), online tendering (10%) and purchase orders (7%).

According to many leading experts (Anumba et. al., 2000; Elliman and Orange, 2000; Alshawi and Ingirige, 2002), the Internet has the potential to transfer complex information accurately, speed up transactions and provide instant access to information from anywhere and at anytime. One section of the survey questionnaire was therefore aimed at establishing the industry's view of the potential benefits of e-commerce. The questionnaire presented ten possible benefits and encouraged the respondents to include additional benefits. The results indicate that most respondents have a neutral view of the benefits of e-commerce to construction (Figure 9), with a majority of respondents unsure of the exact benefits of e-commerce to their respective organisations.

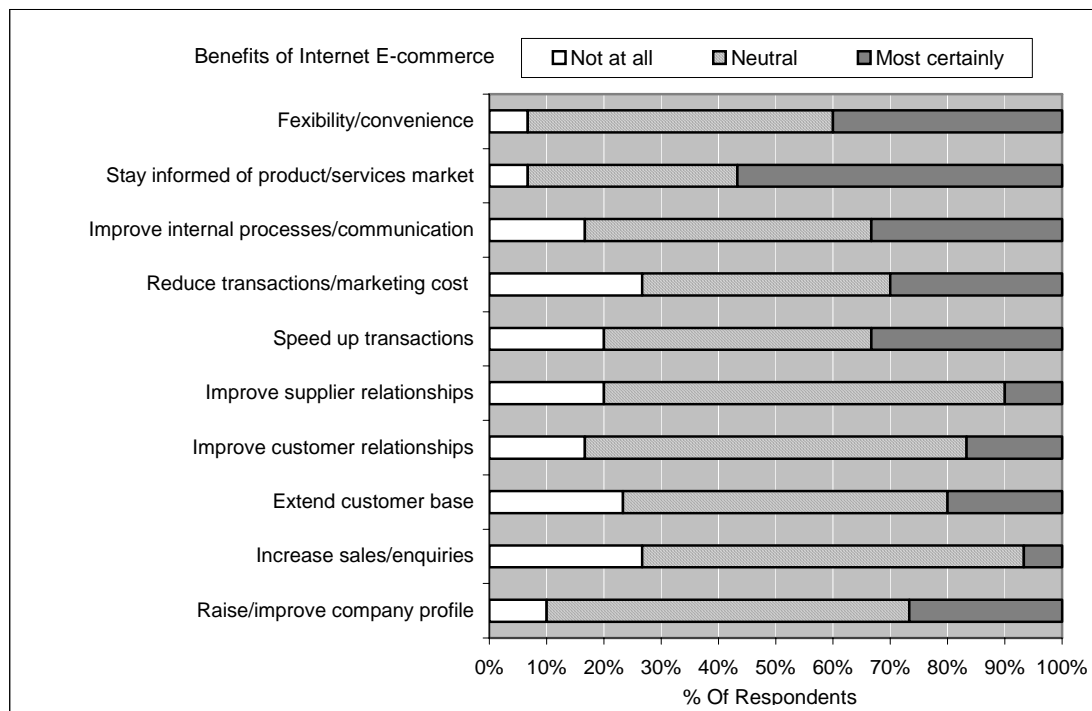


Figure 9. Benefits of Internet E-commerce

Unlike other industries, the construction industry has been relatively slow in the uptake of e-commerce. It was therefore essential to obtain the industry's viewpoint on the main barriers to e-commerce in construction. Issues related to Internet security and a lack of standards for information exchange across networks, as the two main barriers for using

e-commerce. This could be one of the main reasons for the limited use of the Internet for financial transactions such as billing and invoicing, online tendering and purchase orders. Although security issues have been considered as a top priority at cross-disciplinary level, these are not viewed as high priority in IT implementation, which is usually within the organisation itself. Cultural issues, associated with the transition from traditional methods to the use of new tools, are also seen as a major barrier. Other issues associated with using the Internet, such as the invasion of privacy and unsolicited mail are, however, not seen as major deterrents for e-commerce adoption.

CONCLUSIONS AND FUTURE WORK

The survey results revealed that there is a considerable usage of IT applications in the day-to-day working of most UK construction organisations and the level of IT investments largely depends on the size of the organisation. The results show that most firms use email as a vehicle to communicate with peers. It has also shown that although the Internet is being used to obtain construction related information and data, the construction industry has been relatively cautious in the use of the Internet as a mechanism to conduct day-to-day business. Many in the construction industry believe that the future of e-commerce in construction is still quite unclear and the objectives for using e-commerce technologies in construction have not been clearly defined. This may be due to the lack of a well-defined business process model that integrates e-commerce with the existing infrastructure of construction companies. In order to adopt IT and e-commerce strategies into the day-to-day working of construction projects, companies will have to radically alter the traditional processes of managing construction projects and also the way in which project partners collaborate and communicate with one another. It is therefore, essential to study and examine the effects of incorporating e-commerce and IT based applications into the construction business process. One of the benefits of adopting e-commerce can be a streamlined and more efficient construction business process that uses electronic tools for information exchange and data flow. There is potential for research in the area of development of business strategies for the effective adoption of new technologies such as e-commerce in construction.

Although e-commerce and IT usage can be beneficial to construction there are several outstanding issues such as security that need to be addressed. Reliance on computers requires the working environment to be secure. The high degree of computer dependence and newer systems such as networking and the Internet have made it essential for organisations to invest in computer security systems. Organisations must develop policies to detect computer attacks and prevent computer-related crimes. Barriers to electronic commerce such as security and privacy issues are being further rectified through the introduction of new legislation and data encryption standards. When projects are managed using on-line collaborative tools a huge database of information is created. On completion of the project the data needs to be archived (currently on CD-ROMs). There are concerns about future accessibility of this data when current technologies become obsolete. Thus construction-sector organisations should take measures to ensure continued access to project information (Berning and Diveley-Coyne, 2000).

The following recommendations can be made based on the study presented:

- There is potential for conducting future research in the area of development of business strategies for the adoption of e-commerce, including the most appropriate e-commerce business model(s) for the construction industry.
- Construction organisations need to explore the new opportunities offered by e-commerce and re-engineer their business process to maximise the benefits.
- Changes that occur in the construction business process due to the adoption of IT and e-commerce measures need to be continually monitored and documented so that a best practice strategy for their adoption in construction can be formulated.
- As e-commerce is still in the early stages of implementation in most construction organisations there are very few performance measurement tools available to quantify the benefits. More performance measurement tools need to be developed as the technology usage matures.

Based on the findings of this survey, literature review and interviews work is currently in progress to propose a representative construction business process model that uses the principles of BPR. This model proposes the use of IT and Web-based tools in the construction business process with specific focus on construction suppliers and end-users. Clearly, the construction industry has much to gain from the adoption of IT and e-commerce. Greater investment in the enabling infrastructure and in staff training is vital if these benefits are to be realized. The survey results indicate that the UK construction industry has an unclear understanding of the possible benefits of e-commerce. Thus, if the short-term and long-term benefits of adopting e-commerce technologies are made clearer and are found to be profitable, then all barriers to its adoption can be more readily addressed.

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