

REFOCUSING COLLABORATION TECHNOLOGIES IN THE CONSTRUCTION SUPPLY CHAIN: LOOKING BEYOND THE ORGANIZATION

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This paper presents the results of a survey carried out as part of a wider LINK/IDAC project involving an international design-manage-construct (DMC) organization and 11 of their first tier specialist suppliers/contractors. Using a methodology from a previous investigation into the application and issues surrounding the application of ICT's (Information and Communication Technologies), the data is compared to the earlier survey in 1996. The findings indicate that the emergent ICT's of 1996 have been broadly adopted by the supplier base and that the organizations involved are now undergoing a shift from the internal focus by suppliers on their own organizations towards an extra-organizational perspective reflecting the trend towards collaborative working practices. The paper concludes with the identification of barriers to the adoption of collaborative ICTs together with a brief review of how supply chain management can be used to address them.

Keywords: collaborative working, design, information technology, supply chain.

INTRODUCTION

The increasing fragmentation of the construction industry has led to an interest in practices and techniques whereby clients, consultants and contractors can access the skills and knowledge of other organizations. Initiatives such as CRINE in the process engineering industry and Building Down Barriers in the construction industry have emphasized the benefits of working collaboratively with the 'supply chain' and the timely access to the supply chain's expertise.

This survey is part of a wider project titled Integrated Collaborative Design (ICD) which has focused on the increasing role in design played by specialist contractors and suppliers. These organizations can account for up to 90% of the value of the work undertaken (Ndekurigi, 1988; Gray and Flanagan, 1989). The project provides an opportunity to examine in detail the working relationships between a design manage construct (DMC) organization and 11 of its first tier suppliers. The suppliers were drawn from the business sectors of cladding, building services, ductwork, building management systems and clean room environments.

The ICD project has focused on value engineering (Austin and Thomson 1999), supply chain management (Fernie *et al.* 2000) and modelling the design processes across organizational boundaries by mapping information flow (Austin *et al.* 1999). However, the opportunity existed to apply a questionnaire used on a previous research project (Jamieson *et al.* 1996) to investigate the level of utilization of information and communication technologies (ICTs) within the supply chain. A comparison with the

1996 survey would indicate whether these technologies were being 'refocused' from internal organizational issues towards collaborative working practices as suggested by Jamieson *et al.* (*ibid.*).

ICTs and collaborative working

The construction industry is a collection of disparate organizations who work together on projects as temporary multi-organizations (Bresnen 1990). This makes it ideally positioned to benefit from the use of ICTs. The issues surrounding information flow and communication have been high on the industry's agenda since the Tavistock Report (Higgin and Jessop 1965). The benefits of managing information within the supply chain are evident from other industry sectors. This is mirrored in the growth of firms such as SAP who have built their businesses on integrating supply chains through ICTs. This has created an environment where collaborative working in the construction industry is also seen as an area where ICTs can bring lasting benefits (Baldwin *et al.* 1996).

Adoption of ICTs and the Technology Camel

The refocusing of ICTs towards collaborative working is likely to follow the cycle of adoption described as the Technology Camel (McNurlin and Sprague, 1998). The phases of adoption of innovation or technology are seen as parts of a two-humped camel (see *Figure 1*) with its head inside the 'technology tent' representing in this case computer supported collaborative working (CSCW). Clusters of users/adopters are located on the camel's back representing early adopters, early majority, late majority and technically averse groups.

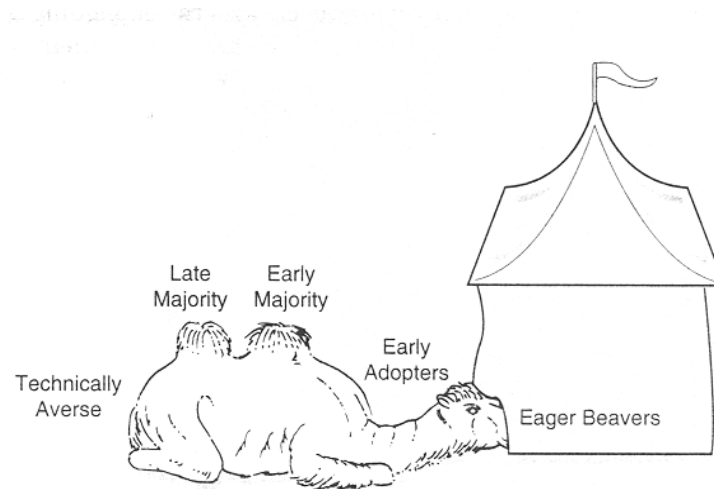


Figure 1: Ghaffari and McNurlin's Technology Camel (McNurlin and Sprague 1988)

Viewing collaborative technologies this way, the early adopter represent the individual 'visionaries' who are always pushing at the edge of what is possible and seeking to use the latest technologies. In construction this might mean expert clients such as BAA and Argent for example, who voluntarily take a leading role in promoting innovative practices within the industry. The early majority would be the firms in the supply chain that support this group. Initially, only a small part of the industry will interface with the projects where the new technologies and ways of working are being implemented (e.g. T5 at Heathrow). The late majority represents firms who adopt practices and technologies that have been tested by the early adopters and the early majority. Previously rare technologies become widespread as standards

are established or *de facto* standards (such as Microsoft Office or AutoCAD) emerge. The technically averse are those who reside in the traditional areas of the industry and operate in markets where new practices are likely to be unwelcome, or where the size of the projects do not make such IT investment worthwhile such as small scale maintenance work.

In collaborative working, benefits come through widespread adoption of the technologies. As more companies adopt them, the greater the potential benefits. Conversely, limited usage acts as a deterrent to their use on individual projects. If the industry is moving from an internal, organizational focus on ICTs towards an external collaborative focus, this should be evident within the supply chain of a DMC.

METHODOLOGY

A questionnaire was modified from an earlier IT survey carried out in 1996 (Jamieson *et al.* 1996). This aimed to identify specific areas of information and communication technology relevant to business to business (B2B) communication, with specific attention paid to the integration of design activities such as computer supported collaborative working (CSCW) and the electronic exchange of information. Due to the limited sample size, it was recognised at the outset that the data would not be suitable for extensive statistical analysis, however the semi-structured design of the questionnaire could be applied to a wider sample if required, thus generating useful statistical inferences. The open answer options within some questions also allowed the respondents to contribute freely on the various topics. The questionnaire generated completed responses from ten of the eleven firms approached. These were collated and compared to the data drawn from the previous survey of 35 organizations representing part of a main contractor's supply chain.

EXISTENCE OF AN ICT INFRASTRUCTURE

Collaborative working requires the integration of communications taking place across organizational boundaries to provide an integrated approach to delivering a project. In using ICTs, this requires the existence of a physical communications network.

Use of computerized information systems

Unlike the 1996 survey, the 2000 survey focused on the level of computerization within activities rather than identifying the use of particular software packages (e.g. Access, AutoCAD etc.). The 1996 survey indicated that a number of commonly available systems had been widely adopted. If the firms involved in the 2000 survey are representative, it would seem that these systems have become embedded within supply chains (see *Figure 2*). Other systems have also been widely adopted particularly in the areas of presentation (Microsoft's ubiquitous PowerPoint), client/customer information, estimating, site management, and document management. The relatively recent penetration of these systems may indicate that these are not fully mature and organizations may not yet be leveraging the full benefits of them.

The widespread usage indicates that these activities are in the late majority of the technology camel, however the recent rapid increase in the penetration of several of these systems again supports the argument that the adoption within the construction supply chain is still relatively immature indicating organizations' IT strategies are still largely concerned with initial adoption rather than upgrading existing systems.

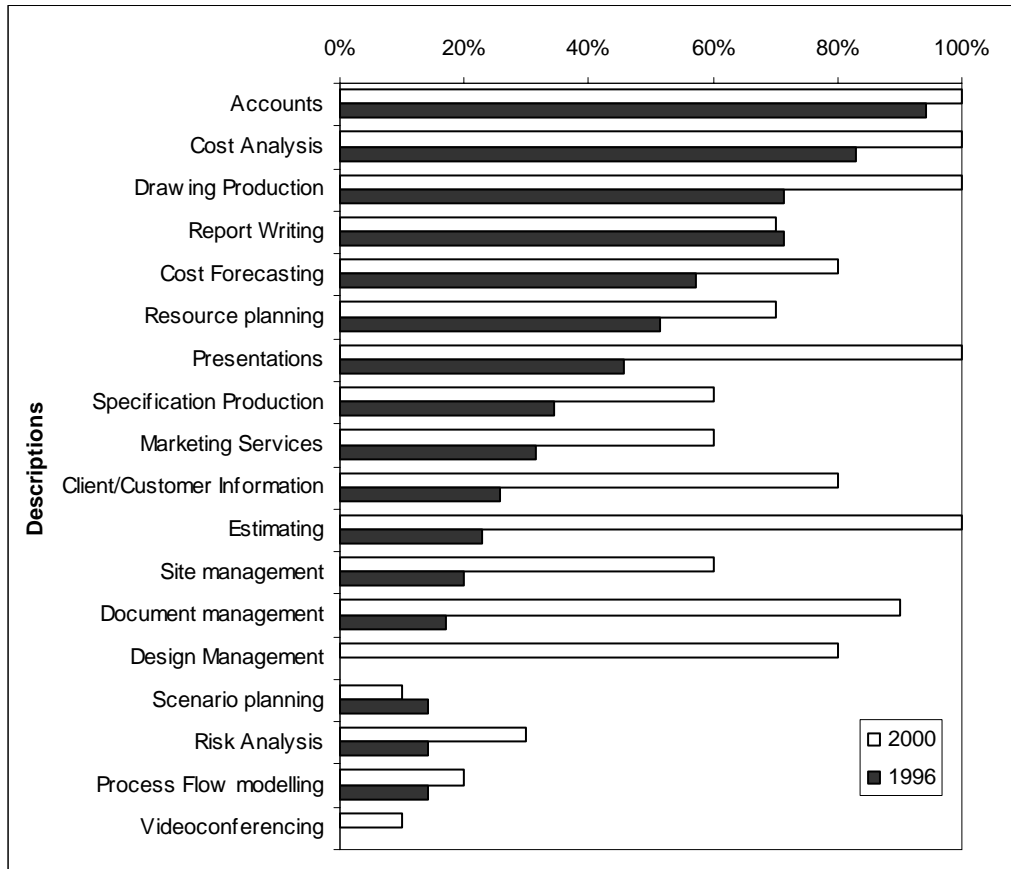


Figure 1: Extent and Areas of ICT Usage

Mechanisms of information exchange

The 1996 survey concluded that the transfer of information was not being undertaken effectively between organizations. This was supported by the most common means of communicating electronic information being the physical transfer of computer disks. *Figure 3* indicates that in the 2000 survey this is still the case. The limited adoption of file transfer and drawing management exchanges reflect a limited adoption of CSCW or groupware applications. The high usage of e-mail, and continued reliance on physical medium such as CD's and disks, lends support to the proposition that existing electronic exchanges are either a supplement or substitute for other mediums (traditional paper copies) that broadly follow existing communication routes which support existing working practices rather than reflecting new ways of working. In contrast CSWC is a relatively sophisticated form of cross-organizational working, which is a step beyond the electronic communication of information, which requires the redesign of working practices and processes for maximum benefit.

The fact that a relatively high level of electronic information exchange is taking place outside of a collaborative infrastructure raises the question of where the communication is occurring. The high levels of usage existing within the organizations between site and other permanent facilities supports the argument that the ITfocus has been internal. However, *Figure 3* also indicates a high level of communication between first tier suppliers and the principal designers and main contractors. This indicates that the basics for CSCW in terms of familiarity with e-mail and the electronic transfer of files is in place. However the requisite changes in

work practices and the cultural and behavioural components necessary under a mature CSWC system are not yet established and these areas are still the preserve of the ‘early adopters’.

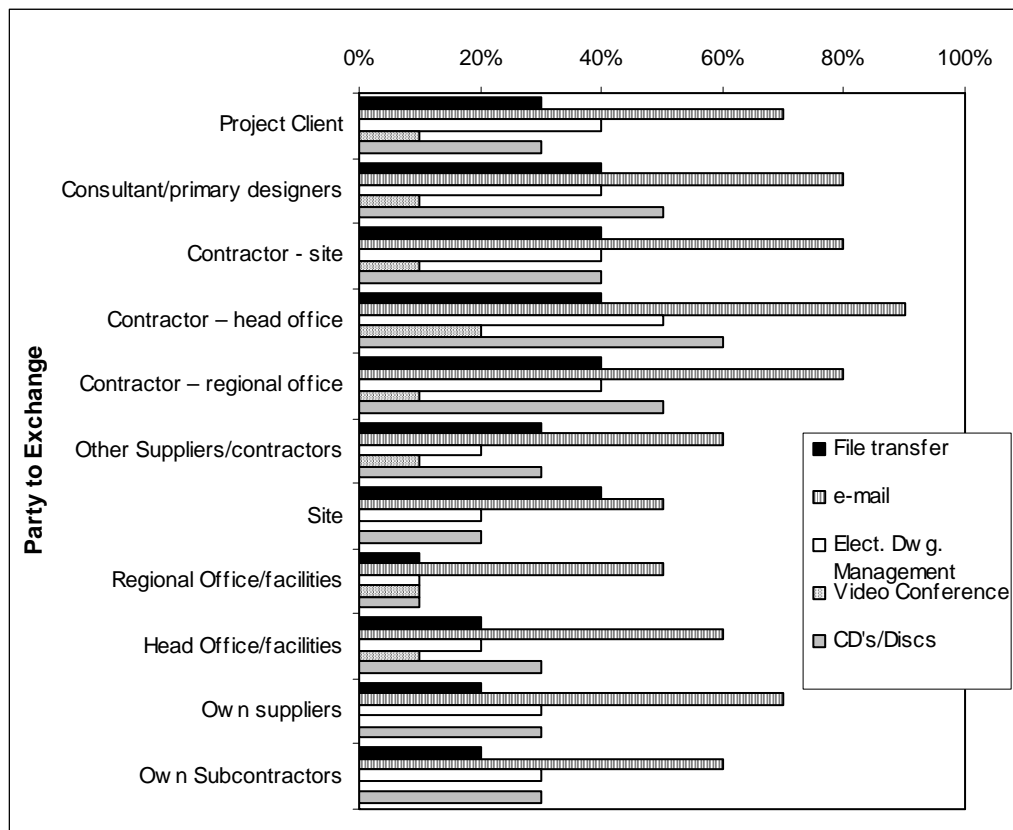


Figure 3: Mechanisms of information exchange within and between project parties

Collaborative Computing

In support of this premise, only two out of the ten collaborators (1996 =34%) were familiar with the term Computer Supported Collaborative Working (CSCW). This refers to the use of computing as a communications tool and a medium for co-ordinating group efforts. Examples include shared files, ‘redlining’ and use of ‘groupware’. The use of applications identified in *Figure 2* and the relatively low penetration of groupware applications shown in *Figure 4* indicates a slow adoption of ICTs to support the cross organisational issues necessary for collaborative working.

Interestingly, the specific options of shared files and shared databases were recognized and used, however, these seemed to be driven by the requirement to use specified applications on particular projects (see below). This also supports the proposition that whilst many ICTs that are focused internally have achieved the late majority stage of adoption, the collaborative use of ICTs is still in the early adopters/early majority stages of the technology camel.

Project requirements for specific applications

The early adopters stage surrounding the use of collaborative ICTs, would as previously indicated be driven through individual projects and client organizations. The lack of industry standards in terms of software applications at this stage would lead the early adopters to encourage the use of particular applications on those

projects they were involved with. Consequently, there will be some projects where applications are required (where the early adopters have an input) and others where they are not (the rest of the industry).

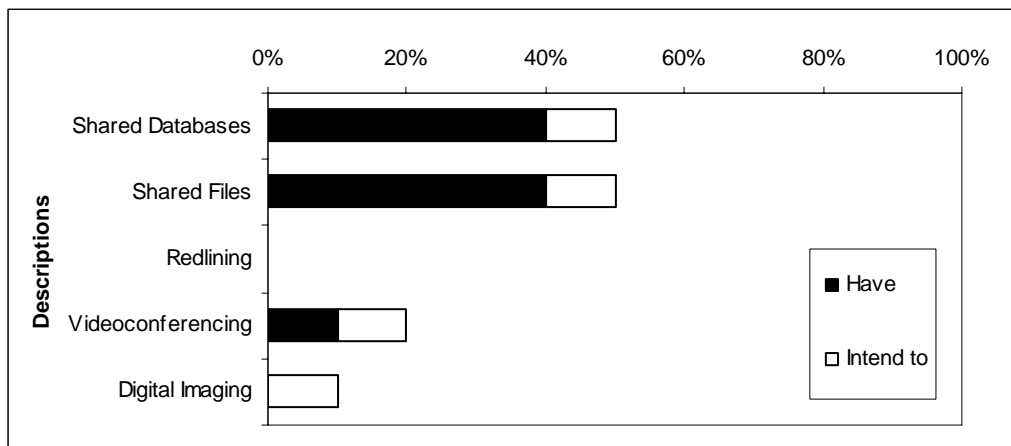


Figure 4: Level of existing and intended implementation of CSWC

Figure 5 indicates just such a differentiation. The fragmented nature of the industry means that some specialist firms will migrate to particular types of work. The frequency of being required to use particular applications will vary according to whether a firm supplies the market where the early adopters are likely to exist or the wider market where they are less common. The fact that a high proportion of the respondents are often required to use specific applications indicates that a degree of refocusing is occurring within the supply chain.

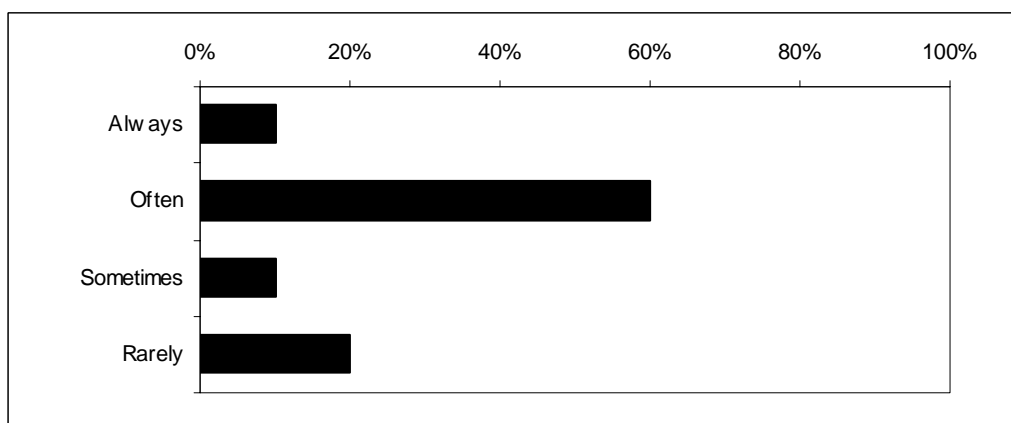


Figure 5: Required Use of Specific Applications by Clients, Contractors and Designers

BENEFITS AND BARRIERS

The issue of changes in work practices and the cultural and behavioural environment that would affect this refocusing and allow firms to take advantage of the available technologies raises the question of the relevant benefits and barriers to implementation and adoption.

Benefits to the organizations

Of the respondents, 8 out of 10 indicated that the ICT's mentioned in the previous questions presented new benefits to the organization (94% in 1996). This indicates an awareness of the inter-organizational issues surrounding the use of collaborative ICTs. The two companies that gave negative answers are highly IT focused firms that provide building management systems. This may indicate that that any relevant benefits have already been derived and that both are early adopters or in the early majority. In addition the nature of their activities may not gain so significantly from ICTs e.g. co-ordination clashes are likely to be more of a problem to ductwork contractors than for controls, due to the physical constraints on installation.

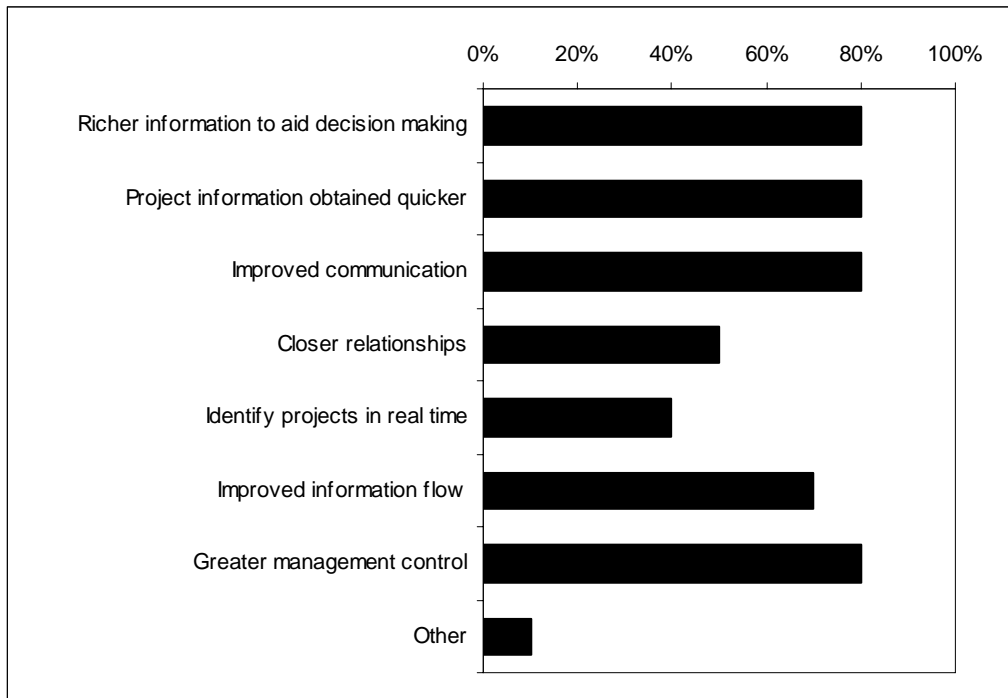


Figure 5: Main Benefits of ICT's

Where benefits were identified (*Figure 6*) these were broadly similar in response to the 1996 survey:

- faster flow of information (and improved access to that information i.e. through visualization techniques);
- faster decision making by clients and designers (through the provision of information which is accurate and up to date); and
- faster and more efficient production of drawings.

The lack of any significant differences in the benefits identified between the two surveys indicates that underlying concerns remain about the application of ICT's across organizational boundaries, which would again be expected at this stage of the technology camel.

Barriers to ICT usage

The primary concern of organizations remains the cost of keeping up to date with the technological developments in training and hardware/software. This is linked to a lack of strategic direction within the industry, both in terms of overall direction and the

standards and protocols that would inform any IT investment decision. This is a characteristic of the early adoption/early majority stages. The lack of any critical mass in terms of workload requiring IT infrastructure acts as a barrier to IT investment. However, there is probably a paradox in that clients and main contractors are unwilling to give that direction on the basis of the perceived lack of IT capability within their supply chain.

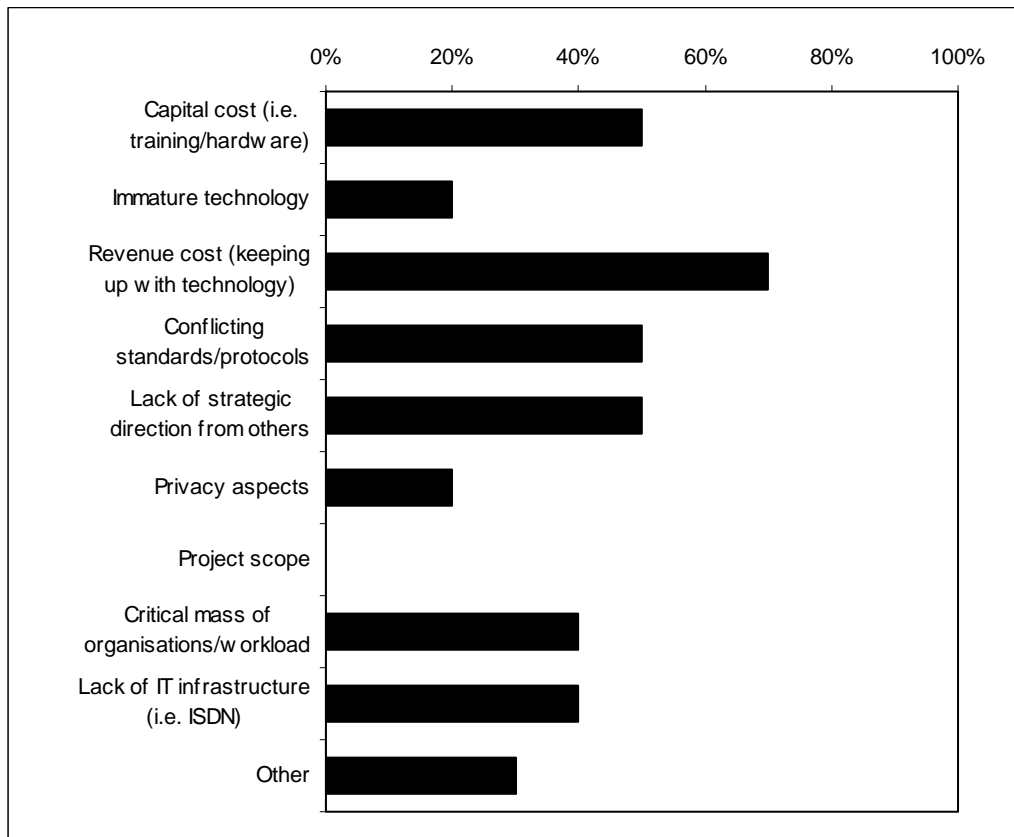


Figure 7: Main barriers to the use of ICTs

Where other barriers were indicated, these were mainly problems of staffing (obtaining and retaining capable and trained personnel). The other concern related to the climate of the industry and the compatibility between working methods and organizations. If changes to working methods are demanded in response to the adoption of CSCW, then issues such as lack of trust in the commercial project environment will need to be addressed.

OVERCOMING THE BARRIERS THROUGH SUPPLY CHAIN MANAGEMENT

Whilst the survey addressed the issue of the existence and usage of collaborative ICTs in the supply chain of a DMC, the actual principles of supply chain management address many of the barriers that face organizations in moving towards the collaborative use of ICTs. The holistic approach of supply chain management (Ferne *et al.* 2000) requires organizations to look beyond their boundaries to deliver enhanced performance. The need to develop narrower and deeper relationship between members of the supply chain also provides an environment where a degree of stability will enable companies to make the necessary IT investment decisions.

Supply chain management requires projects to be viewed as flows of information as well as goods and services (Root *et al.* 1999). This enables the interfaces between organizations to be mapped and aligned making the management of these complex information flows information technology through the application of ICTs worthwhile.

CONCLUSIONS

The organizations involved in the ICD project were selected on the basis of their high levels of design input to the project process and their willingness to develop new ways of working. As such, the organizations would be expected to be amongst the early adopters or early majority and so reflect a higher level of sophistication and organizational development than the norm. Acknowledging this and the limited sample size, a number of useful observations can be drawn from the research exercise:

The construction supply chain (or supplier base) have adopted many of the basic IT applications and integrated these ICT technologies within their internal business and project processes. These applications are relatively mature in implementation although the technology still has the potential to leverage further benefits (i.e. limited use of digital cameras when e-mail is widely utilized between site and office).

In contrast, organizational boundaries still act as a significant barrier to the implementation of ICTs. Current electronic information exchange broadly replicates existing communication paths, typified by in the continued use of discs and CD's to convey information.

The current approach to IT by the firms surveyed in the ICD project indicates that the supply chain is beginning to shift from a particular level of IT maturity where applications are internally focused whilst allowing electronic information exchange to one which is more focused on inter-organizational collaborative working such as GroupWare. This reflects a change in the nature of the ICTs and working practices in order to leverage the benefits of using it than the existing IT technology demands. Although concerns exist, the maturity of the technology is not seen as a significant problem. This confirms the suppliers' broad appreciation of the barriers to adoption being external to their organizations and affecting their IT investment decisions (i.e. strategic direction from clients and the workload to justify IT investment reflecting the historical tradition of allocating IT expenditure as a project rather than a business cost).

There is a common, solid understanding and appreciation amongst the collaborators of the benefits that can be gained concentrated on the greater control of projects, through better decision making on accurate information and the achievement of consistency within organizations, across departments and offices.

Together, these conclusions indicate the need, for more attention to be paid to the environment surrounding ICT investment decisions including the alignment of the business strategies of firms who are intending to collaborate in order to gain the benefits that ICTs can provide. As has been shown, supply chain management can actively contribute to this.

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