

THE POTENTIAL OF COLLABORATIVE ENVIRONMENTS IMPLEMENTATION IN SMALL AND MEDIUM ENTERPRISES FOR THE CONSTRUCTION INDUSTRY

Aisha Abuelmaatti¹ and Vian Ahmed

School of the Built and Human Environment, University of Salford, Salford, UK

Emerging technologies in the UK offer the construction industry many opportunities for computer supported collaborative environments to address some of the aspects that result in a complicated and complex construction process. However, the companies adopting these technologies usually fail in achieving the full benefits from their implementations. The use of collaboration technology remains low among 99% of companies in the UK construction industry usually referred to as Small and Medium Enterprises (SMEs < 250 employees). The paper firstly reports results of a literature review on the benefits of collaborative environments and barriers to its implementation. Secondly, it summarizes the results of case study providing the perspective of construction SMEs on the current success level and success criteria. While SMEs are key players in supporting large construction companies adopting collaborative environments, the paper reveals that there is lack in introducing collaborative environments to SMEs with regards to the management required in order to obtain the full benefits from their implementation. The paper then concludes with some insights into how construction SMEs can improve the implementation of collaborative environments and the necessity to developing an approach blending the right combination of factors which are believed to contribute towards the improvement and implementation of collaborative environments

Keywords: collaborative environments, SME.

INTRODUCTION

There is a high collaboration requirement in construction due to its multi-organizational and geographically dispersed project nature. The UK construction industry has come a long way since the Latham (1994) report was published and the subsequent Egan (1998) process. Many of these reports' recommendations have been implemented, and numerous enterprises have begun to adopt more collaborative working. It ensues naturally that demand for collaboration technologies that allow collaborative working may only grow as the enthusiasm for team working grows. Indeed, many tools are currently used and the industry is constantly searching for new, more efficient and effective IT based collaboration methods (Peña-Mora, *et al.* 2002; Roshani *et al.*, 2005; Goulding, 2007).

In analysing the adoption of collaboration technologies in terms of the traditional product lifecycle approach, Wilkinson (2005) argued that following the simulation of

¹ a.m.t.abuelmaatti@pgr.salford.ac.uk

awareness and interest in collaboration technologies in the construction industry by the clients who are open to innovation, the industry had successfully passed the development and introduction phases and by the mid 2000s had gone on to the growth phase. Although large companies have been successful in intra-company adoption of collaboration technologies, the companies adopting these technologies fail in achieving the full benefits from their inter-organizational implementations. In fact, 80 to 90 per cent of IT investment did not meet their performance objectives (Alshawi, 2007). Although there have been some successful intra-organizational examples, the benefits of collaboration tools are not yet proven industry wide (Allen *et al.*, 2005; Wilkinson, 2005; eBusiness W@tch, 2006; Hassan *et al.* 2008; Erdogan *et al.*, 2008).

The problem in the construction industry is not a lack of technology but more a lack of awareness of how to fully exploit it and what factors are important in order to allow this to happen (Betts and Smith 1999). Let alone the fact that, the increasing attention levelled at the importance of collaboration technology seems to be targeted at the very large organizations, with little attention being directed at SMEs. This is despite the fact that SMEs play a central role as their competitiveness is, arguably, indispensable to a country's growth and success (OECD, 2000).

Ninety nine percent of organizations in the UK construction industry are SMEs (DETR, 2000). It is widely recognized that they perish quicker than large organizations, partly due to lack of profitability, and that their profitability is linked to performance. This poses the problem of what are the most appropriate working environments available to match the SMEs in the construction industry. The construction reports push for collaboration tools as one solution to this problem, i.e. to improve performance. While there is an increasing attention levelled at the importance of the integration of IT in business environments in general, previous research related to the implementation of IT based collaborative environments seems to be directed at the very large organizations, with little attention being directed at SMEs. Given that SMEs deliver 52% of the construction industry's workload in monetary terms (DETR, 2000), it ensues naturally that they are key players in supporting large construction companies. Therefore, SMEs good performance and survival in the industry is vital. This is the reason to why this research attempts to investigate ways of getting the SMEs to engage more effectively in collaboration initiatives to meet the demands of an over growing industry, while increasing their overall competitiveness.

The aforementioned would lead one to raise the following questions regarding collaborative environments implementation in construction SMEs.

- What are the main barriers SMEs face in implementing collaboration initiatives in the construction industry.
- What are the technologies used and how effective are they for collaboration in SMEs in the construction industry.

This paper is based on extensive literature review and case study results intended to provide answers to the aforementioned questions and insights for the deficient research. An attempt to answer these questions leads to the following objectives.

- To develop an understanding of collaborative environments in the industry.
- To explore the efficacy of different technologies for collaboration in SMEs and their current collaborative working approaches in construction.
- To identify the failure reasons for ICT and the factors that facilitates effective collaboration environments implementation in SMEs.

In order to achieve these objectives, the results of an extensive literature review on the benefits and barriers behind IT implementation are highlighted. The results of exploratory case studies are summarized to show the current IT implementation for collaborative working approaches with particular focus on presenting the current success level and success criteria adopted by construction companies.

COLLABORATIVE ENVIRONMENTS AND SMES

Collaboration technologies are of extreme importance for the nature of construction projects at the point in time when the need for efficient collaboration arises. The following definition for collaboration technologies by Wilkinson (2005) is considered to be the most appropriate definition for the purposes of this research: a combination of technologies that together create a single shared interface between multiple interested individual, enabling them to participate in creative organization in which they can openly share their collective skills, expertise, understanding and knowledge, and thereby jointly deliver the best solution that meets their common goal, while simultaneously creating an auditable electronic record of the information employed in the delivery of the solution.

Although collaborative environments is a topic of increasing importance to practitioners as well as researchers in construction, its optimal extensions of use have not yet been thoroughly investigated. Despite research efforts, there are still a number of barriers to its implementation. Statistical evidence in (Barbour 2002, p.31) found that, on average, 2% of projects in 2001 were managed using project collaboration tools, with use greater among larger enterprises; a year later (Barbour 2003, p.14), it said 13% claimed their teams used such technology. In 2004, according to the IT Construction Forum, 34% said that they used project extranets to collaborate online. The DTI benchmarking study (2004, p.52) found 17% of construction businesses claiming to be extranet users. However, use among SMEs remained low (Wilkinson, 2005 p. 105; eBusiness W@tch, 2006). A 2004 survey of more than 800 members of the National Federation of Builders which represents over 3,000 SMEs found that only 3% of respondents had used project collaboration tool. While it is difficult to get reliable and consistent statistical information, it can be deduced that collaboration technologies had begun to achieve credibility with some leading companies.

Most of the published literature describes and discusses the application of collaborative environments in large organizations (Wilkinson, 2005; eBusiness W@tch, 2006). It can be said that the attention paid to the implementation of collaborative environments in large organizations is understandable as these organizations traditionally have been championing the concepts ahead of SMEs. There is no distinct and uniformly acceptable definition of SMEs. Storey (1994) and Burns (2001) among others state that the choice of measure is flexible and it does not matter in practice which measure is adopted, for most measures are correlated with each other. Hence, the definition of SMEs in this research is based on the numbers of employees, where organizations with fewer than 250 employees are considered as SMEs as adopted by the Department of Trade and Industry in the UK (1999); and the EU (2003). Adopting the work of D'Amboize and Muldowney (1988); Spence (1999) and Yusof and Aspinwall (2000) enables compiling a list of characteristics for SMEs categorized as top management, culture and behaviour, structures, system and procedures, human resources, resource acquisition, decision making and planning processes, risk taking and dealing with uncertainty, technology and training.

The environment in which collaborative environment is implemented would not be an issue if SMEs and large organizations possessed similar characteristics. In practice however there are significant differences between SMEs and large organizations. These differences are likely to influence the implementation of collaborative environments, and achieving the full benefits from their implementations.

POTENTIAL BENEFITS

Collaborative environments offer SMEs numerous advantages. It may suffice to categorize the benefits cited in literature under tangible and intangible in nature.

Tangible Benefits

The most frequently claimed savings tend to relate to tangible or quantifiable benefits such as cost reductions and time savings. Collaborative environments use numerous centralized application servers and instead of concentrating power in the desktop computer as is currently done. Collaborative environments potentially provide savings in time and resources compared to in-house solutions, which can be costly, time consuming, and maintenance-intensive, and many require a high degree of expertise by the system administrator and user to implement (Wilkinson, 2005; Erdogan *et al.*, 2008). Let alone reduction in expenses relating to printing, reproduction, distribution, storage, management and retrieval of drawings, documents, photographs, forms, travel for meetings, time spent searching for or chasing already existing information or working on out of date information, faster drawing revision cycles and other approval processes (Ruikar *et al.*, 2005; Shelbourn *et al.*, 2007). There is still considerable scope for SMEs in the industry to achieve these benefits and more.

Intangible Benefits

It is, of course, more difficult to document savings relating to soft, indirect, intangible or more qualitative benefits. The claimed benefits can again be roughly divided into the key risk areas of time, cost and quality. Besides, in an industry often maligned as low-tech; indirect benefits for SMEs certainly include an improved reputation with clients at both company and industry levels. In fact, recently, construction companies found that they must make a larger investment in ICT to attract and retain collaboration. However, it will continue to be relatively difficult and expensive for construction SMEs to attract the best talent away from cutting edge high technology companies (Wilkinson, 2005; Alshawi, 2007; Erdogan *et al.*, 2008). It is worth noting that as collaborative environments providers attempt to differentiate their products from those of their competitors, they continue to expand their internal feature packages and to develop linkages to important external software. These upgrades are incorporated on the provider's central server, giving the client immediate access to new features with no need to purchase and install new versions or upgrades (Björk, 2002; Ruikar *et al.*, 2005; Erdogan *et al.*, 2010). In addition to the benefits that collaborative environments may provide, some important barriers to implementation still exist. It is worth noting that the barriers are not as one-dimensional and straightforward as many think. These barriers need to be addressed in order to increase SMEs confidence in adopting collaborative environments in construction projects.

BARRIERS FACING SMES

The reason for the 80-90% of IT investments not meeting performance objectives (Alshawi, 2007) is found to be rarely technical (Laudon and Laudon, 2000; Clegg *et al.*, 2001; Kurupparachchi *et al.*, 2002; Shelbourn *et al.*, 2007; Erdogan *et al.*, 2010). Central to the problem discussion is that the barriers may be considered to occur on two levels, namely; technical level and management level.

Technical level

The temporary nature of relationships in a construction project provides little or no incentive for investing in innovative technologies (Back and Moreau, 2001; Bishop, 2001). It is difficult to persuade every SME participating in a construction project to make the necessary level of investment to fully implement a collaborative environment (Anumba and Ruikarm, 2002). SMEs have been slow to commit to the adoption of collaborative environments on the mere suspicion that collaborative environments reduce cost or improve overall project performance (Wilkinson, 2005; Alshawi, 2007; Erdogan *et al.*, 2008). According to Kuruppuarachchi *et al.*, (2002), three basic requirements should be met for successful implementation of IT projects: a clear business objective; understanding of the nature of change; and understanding of the project risk. The level of complexity and risk of the project depends on project size, project structure and the level of technical experience of the end users and the project team (Laudon and Laudon, 2000).

Coordination and management of information with regards to data access rights, data change rights, database transactions, data exchange standards are causes of barriers. It is also worth noting that a collaborative environment provider may not be able to adequately take care of users' needs or could even go out of business, leaving users without recourse in the middle of a project (Wilkinson, 2005; Ruikar *et al.*, 2005). Also, users still rely mostly on mutual trust between parties, as well as paper-based in parallel when using this scheme (Peña-Mora *et al.*, 2002; Krizan, 2001; Wilkinson, 2005). The aforementioned inadequacy has prevented the creation of complete confidence in the construction industry to adopt collaborative environments.

All the barriers mentioned for IT implementation in construction in general are valid for the collaborative environments in terms of the technology implementation and have a sense of management concerns.

Management level

Focusing too much on technical factors may result in technically excellent systems which are incompatible with the organization's structure, culture and goals since it neglects to consider how the new technology interacts with working practices, work organization structure, job design, and work processes (Laudon and Laudon, 2000; Clegg *et al.*, 2001; Shelbourn *et al.*, 2007; Erdogan *et al.*, 2010).

Collaboration is difficult to establish even as a soft issue regardless of the accompanying IT. The readiness of the organization for the new technology, and the socio-cultural factors, compatibility of the processes and technologies between organizations collaborating on a project are of utmost importance. It is worth noting that each new IT implementation involves some change for the organization and the employees, and is therefore a source of resistance and confusion unless special attention is paid to managing it while it is introduced at an organization level or a project organization level (Rezgui *et al.*, 2005; McAdam and Galloway, 2005; Goudling, 2007; Erdogan *et al.*, 2010); laying emphasis on the organizational and socio-cultural factors role to play.

Uncertainties and risks at project inception ensuing from multiple project information management systems implemented for different projects is a barrier. Also, the density of communication channels in a construction project poses challenges for the use of a collaborative environment. Since other channels exist, it is easy for a project team member to bypass a collaborative environment with more familiar technologies (Wilkinson, 2005; Baidini, 2007). Yet, collaborative maturity is of utmost importance

in representing the level to which team members are willing to work together and share information and experience to make the project succeed. It is suggested that the collaborative maturity of a team varies greatly. Currently, collaborative environments are more useful to a team that possesses a high level of collaborative maturity (Wilkinson, 2005; Alshawi, 2007). However, practitioners in the construction industry are still uncomfortable giving power away even within a team with a high degree of collaborative maturity.

Ownership of data, insurance and indemnity requirements are of utmost importance. Although the existing legal environment may provide essentially clear guidelines for construction practitioners to manage a contract in a paper-based environment, new collaborative tools change the work method, making legal responsibilities in this new environment unclear (Nitithamyong and Skibniewski, 2004; Wilkinson, 2005; Hassan *et al.*, 2008). Also, the actual ownership and control of data after project completion is of considerable importance when implementing collaborative environments (Berning and Coyne, 2000; Wilkinson, 2005; Hassan *et al.*, 2008). In an industry hitherto renowned for its heavy reliance on contracts, there are bound to be concerns about the legal implications of using collaboration technologies, in fact it applies doubly. Indeed, concern about legal factors is a reason why wider introduction of such technologies has been delayed within the industry. This is where legal protection inherent in contractual provisions comes in handy.

It may be easily deduced as such that in addition to the benefits that collaborative environments may provide, some important barriers to implementation still exist, significantly hindering the success of adoption, and should not be overlooked. Thus, in researching, developing, and evaluating the potential of collaborative environments for SMEs, overcoming these issues must be blended successfully toward the collaborative working purpose.

RESEARCH METHOD

As demonstrated in the previous sections, collaborative environments offer substantial benefits to construction companies, but their implementation is still hindered by many barriers. The literature points out to productivity in the construction industry given answers to a number of gaps that need addressing with regard to SMEs to ensure effective adoption of collaborative environments, namely.

- What are the success/failure factors leading to the performance of collaborative environments, and how do they affect its performance.
- Can these factors, if controlled in SMEs, ensure the success of collaborative environments implementation in a construction project.
- What are the relationships, if any, between the success or failure of collaborative environments implementation in SMEs and construction project success.

The methodology to answer the questions consists of a combination of four methods: literature review, case studies, framework development, and evaluation. The literature review established an understanding of the current state of the art for the implementation of collaboration technology in the construction industry and assessed the integration of collaboration technology in SMEs with a focus on the benefits and barriers which should pour into identifying the factors that enable collaborative working using collaboration technology.

In order to obtain the industrial perspective to answer the research questions, a case study research reviewing the current collaborative environment implementation in construction companies was carried out aimed at gathering information on.

- Collaborative environments implemented in construction SMEs.
- Barriers and difficulties in the implementation of collaborative environments with regards to collaborative working procedures; and
- The success measurement of collaborative environments undertaken so far.

In order to answer the research questions in the previous section, there was an inevitable need to investigate the current success level and success criteria adopted which is the focus of the case studies to pour it into blending the right combination of factors to support collaborative environments effectively in construction companies.

CASE DESCRIPTION

The semi-structured interviews reported in this paper were conducted in twelve companies of which eight are SMEs selected on the following basis: each SME should already be engaged in collaborative arrangements; should be using IT to support part of their business functions; should have a strong business focus and area of activity.

The study sample consists of 4 small and 4 medium enterprises, as well as 4 large organizations. The sample was across the construction sector incorporating an assortment of professions to get a blended view of the use of IT for different purposes. Interviews with personnel across organizational hierarchy whom engaged in the collaboration, experienced the difficulties and barriers, and made decisions to overcome them allowed insights at organizational, project and individual levels to be gained. The aim of the following sections is to bring together information from the interviews that lasted approximately one hour to provide a summary of information found in the questions asked. Pertinent questions were asked to explore what percentage of collaborative environments implemented in the SMEs has failed to provide the full benefits expected and investigate how the success of the collaborative environments is evaluated and whether there are any defined success criteria for this.

Current collaborative environments implemented

To assess the adaptation level of collaborative environments, the interviewees were asked to categorize their implementations; namely: whether they used developed a customized environment in-house; purchased commercial web-enabled packaged software; rented/leased a completely developed environment from an Application Service Provider for a usage fee. Among these three options, the third was found the most common implemented by the interviewed companies. The interviewees were asked to determine which of those available to the industry was being used in projects, it can be said that 4Projects is the most commonly used with Asite and BIW the next popular. While Business Collaborator, Buzzsaw, Cadweb, Open Text Extended Collaboration, and Swort CTSpace less used but mentioned.

The study revealed that collaborative environments are not generally implemented in SMEs; however their use is driven by the use of larger companies. The interviewees voiced concerns about unfriendly user interfaces, low speed of transfer and data security problems as the main failure reasons from the technical point of view. Respondents felt that the intuitiveness of these means that much training is needed before project participants can use them.

Current success level and success criteria of implementing collaborative environments

One of the key questions asked was what percentage of collaborative environments implementation initiative has failed? This was followed by asking what percentage of implementation projects would not have been found financially viable if the actual success levels could have been foreseen? The results show up to 50 to 70% failure in providing the full benefits expected. Another question asked was designed to determine what are the success criteria for IT implementation, or specifically for collaborative technology implementation? With regard to the success criteria and how the companies measure the extent to which implementations satisfy these criteria, the case study revealed that they were able to achieve this success analysis perceptually through the means of tangible and intangible comparisons with cases where paper-based systems were used. The following questions were said to be used as objective measures to find out where the cost savings mainly arise from compared to the conventional method, where they used a paper based system, namely.

- Direct tangible savings manifested in “How many drawings were produced?”, and “How much would it have cost to produce those drawings and distribute them in paper-based form?”.
- Intangible benefits manifested in “Did we have more or less rework?”, “Did we have more or less drawing revisions?”, “Did we have more or less Request For Information”, and “How long did it take to resolve our Request For Information?”

It can be seen that these indicators are not only related to the success of the collaborative environment; they are affected by many other organizational and project level factors. Therefore this perceptual analysis does not measure the success solely. These comparisons could fail in measuring the efficiency since sometimes the information is exchanged electronically without the use of the collaborative environment. Furthermore, the values calculated this way would only reflect the benefits obtained due to the automation of the communication and not necessarily the collaborative environment. Measuring the intangible benefits was found difficult by the SMEs, they either choose to do a perceptual analysis or measure the construction project instead of the collaboration technology against a number of benchmarks or key performance indicators defined at the very beginning of the project. This means that none of the perceptual analyses carried out by any of the companies managed to judge the performance accurately. They were mostly subjective and did not include the views of the end users. These analyses failed to provide results that could be used as feedback for future implementations.

SUMMARY

The paper established an understanding of the current state of the art for the implementation of collaborative environments in the construction industry with a focus on the benefits and barriers which revealed five main barriers associated with implementing collaborative environments, namely: lack of top management support, the lack of a provision of appropriate training, the creation of an appropriate culture, the need to adopt appropriate processes, the adoption of appropriate technologies. The most common environment implemented by the interviewed companies was found to be rented/leased completely developed from an Application Service Provider. The study revealed that these are not generally implemented in SMEs; however their use is driven by the use of larger companies.

It can be concluded that collaborative environments present significant benefits to the construction industry, but their successful implementation in SMEs is still hindered by non technical barriers. The characteristics of SMEs in the construction industry suggest that unlike other technologies, collaborative environments are very much concerned with the collaboration across the project life cycle, and their successful implementation therefore will not only require a state of readiness within one organization but also within all organizations involved in the construction processes, which makes the successful implementation of collaborative environments difficult to be planned and managed. Therefore unless supported by the relevant factors, the stand-alone implementation of collaborative technologies will not be able to enhance collaborative working. It is hoped that the paper triggers further research that will contribute to blending alternative though complementary factors which underpin the capability of the companies to successfully absorb collaborative environments into its work practice.

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