DEVELOPING SUPPLY CHAIN INTEGRATION IN BUILDING TECHNOLOGIES CLUSTER

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Website: www.mit.wlv.ac.ukBuilding technologies cluster covers a wide range of materials, products, systems and specialist services supplied by a variety of industry sectors. The supply chain of the building technologies industry within the cluster is currently organized on a fragmented basis. However, instead of treating the steps of the supply chain as individual links, building technologies organizations need to transform their supply chain into more synthesized entities through inter-organizational connectivity with established integrated architecture. Supply chain integration is generally associated with inter-organizational communications, leading to time compression in processes, services and information flows. The fusion of building technologies design, manufacture, deployment in a building projects and building processes management with Information and Communication Technology (ICT) is seen as forming the core of a strategic vision for supply chain integration for the building technologies industry. This paper presents an incitement into the building technologies cluster by developing a framework for a web-based e-supply chain information system. The intent with the proposed system is to deal with the management and transaction of information across network of supply chain partners. It is targeted towards achieving the integrated supply chain working for the integrated project team through an electronic marketplace.

Keywords: building technologies cluster, e-supply chain, ICT, supply chain integration, web-based system.

INTRODUCTION

A supply chain can be defined as a network of facilities and distribution operations to perform the functions of procurement of materials, transformation of these materials into intermediate and finished products, and then distribution of these finished products to customers (Ganeshan 1999; Mabert and Venkataramanan 1998). The concept of the “supply chain” provides a useful framework for analysing the linkages of those parties participating in a construction project, since they are all involved in the supply of resources.

The building technologies cluster which ispart of the wider construction industry, is of considerable importance to the national economy and a wide range of supply industries that support it (AWM 2002). However, the highly fragmented nature with low productivity, high cost, time overrun, conflicts and disputes, negatively affects the performance of the building technologies cluster and the associated construction industry, and has contributed to the emergency of dysfunctional supply chain (Egan 1998; Love et al. 1999; AWM 2002).

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Niu, Y, Nwagboso, C, Proverbs, D and Olomolaiye, P (2004) Developing supply chain integration in building technologies cluster. *In:* Khosrowshahi, F (Ed.), *20th Annual ARCOM Conference*, 1-3 September 2004, Heriot Watt University. Association of Researchers in Construction Management, Vol. 2, 1075-84.

To overcome this fragmentation and realize integration of supply chain, there exists diversity in the realm of supply chain management (SCM) research in the construction industry. Some researchers have focused mainly upon the definition of the supply chain (i.e. Christopher 1992) while others concentrate upon both the definition and the evolution (Tan 2001; Sundaram and Mehta 2002). Closely related is research into the overall makeup and environment of SCM including the structure, process, components and evolution progress (Dyer 2000; Lambert et al 1998; Cooper et al 1997; Poirier and Quinn 2003). Another frequently researched component of SCM is the exploration and understanding of the dynamic information flow and the innovative and strategic deployment of Information and Communication Technologies (ICT). The need for building technologies cluster to harness ICT to realize a network organised supply chain has been emphasized in several research initiatives and government reports (AWM 2002; DTI 2001; DTI 2003; Ruikar et al. 2003).

In recent years there has been a growth in the use of Internet and Internet-based technologies (e.g. E-business) combined with the other ICT components in building industry. The researches on this issue so far have focused on the discrete solutions to the construction process reengineering such as computer aided design, electronic document sharing, knowledge management, etc. However, there is the need for integration of the supply chain activities and relationships. Furthermore, despite the growing awareness in other industry sectors such as transportation and logistics (Roberts et al. 2003), the understanding of the information dynamics with the deployment of ICT, covering EDI, ERP, E-business and telematics (Nwagboso et al. 2004) to integrate the whole supply chain in building technologies cluster remains undefined. As a result, the e-supply chain for the building technologies cluster has not been fully developed.

This paper presents an incitement into the building technologies cluster, its physical supply chain model and explores the key role ICT can play in making the project supply chain more collaborative. The focus of this paper is therefore to present a framework for a web-based e-supply chain information system which will be deployed with the influence of management, system architecture & toolkits integration, information robustness and human factors. The paper also concludes the findings during the first stage of the research with a literature review to reinforce the body of knowledgeof the e-supply chain information system for building technologies cluster. Based on it, the five levels of SCM evolution is developed within the building technologies cluster context.

BUILDING TECHNOLOGIES CLUSTERAccording to the report commissioned by Advantage West Midlands ‘West Midlands Building Technologies Cluster Research Final Report - March 2002’, the building technologies cluster can be defined as follows:

‘Building technologies cover a wide range of materials, products, systems and specialist services supplied by a variety of industry sectors’.

It covers a wide range of supply industries that support the construction activities. It offers a suitable context for the study of the supply chain activities and partnerships in the construction sector. The supply chain in the building technologies cluster is composed of the companies and organisations in:

- core supply industries manufacturing commodity materials, products, systems, /sub-systems and building installation work;

- support industries supplying equipment, tooling, machinery, plant hire, technical/professional services, consultancy services, builders merchants etc to the core supply chain; and
- support institutions providing R&D, training, trade, regulatory, financial and business support and advisory services.

A supply chain framework for building technologies cluster used in the study is summarised in Figure1.

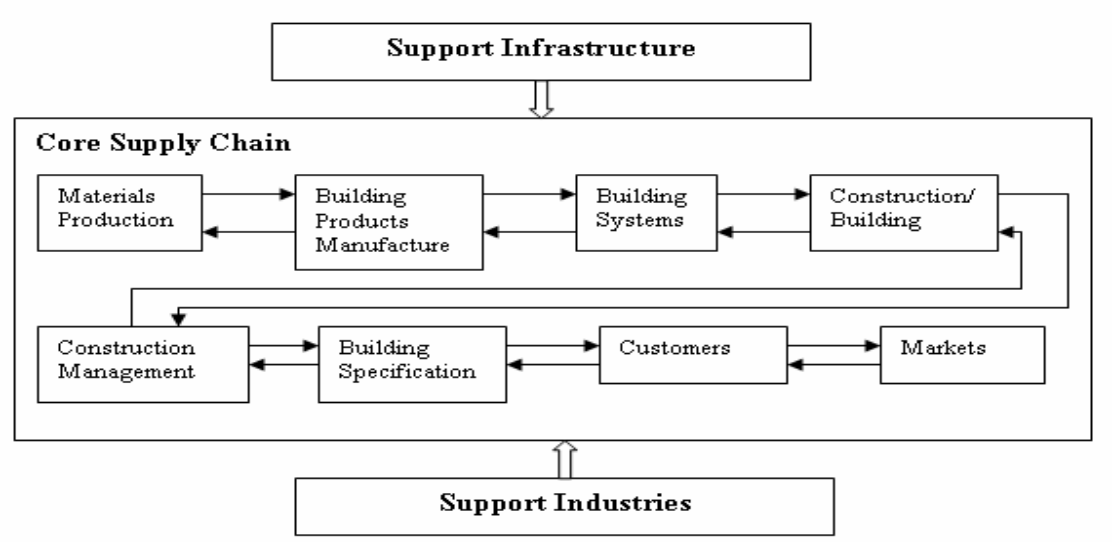

Figure 1 Supply Chain Framework for Building Technologies Cluster

SCM IN THE BUILDING TECHNOLOGIES CLUSTER

In the context of the building technologies cluster, SCM may be regarded as the process of strategic management of information flow, activities, and processes focused towards industrial competitiveness. This normally involves various networks of organisations and linkages (upstream and downstream) that are stakeholders in the delivery of quality construction products, projects and services through the core supply chain. It is also underpinned byvarious support industries/infrastructures focused towards delivering to the customers, in an integrated and efficient manner (Akintoye *et al.* 2000; AWM 2002; Proverbs *et al.* 1999).

The current state of ICT systems deployment in the supply chain management within the building technologies cluster is still under early stages of development. Numerous studies have shown that while some information and communication technologies is being widely used in the building technologies cluster, they have so far focused on the discrete solutions regarding to the specific requirements in the separate linkages of the supply chain (Tolman 2001; Amor 2002; Mohamed 2003). But the integration of the supply chain should aim to boost efficiency and effectiveness across all supply chain members and linkages. Therefore, the building technologies cluster is still expecting an integrated supply chain information system with the flexible dynamic information flow structure.

Based on the initial investigation, it is proposed that a five level evolution of the SCM can be used in the building technologies cluster for realization of the integrated supply chain information system. These levels are influenced by the cross cutting factor of network connectivity.

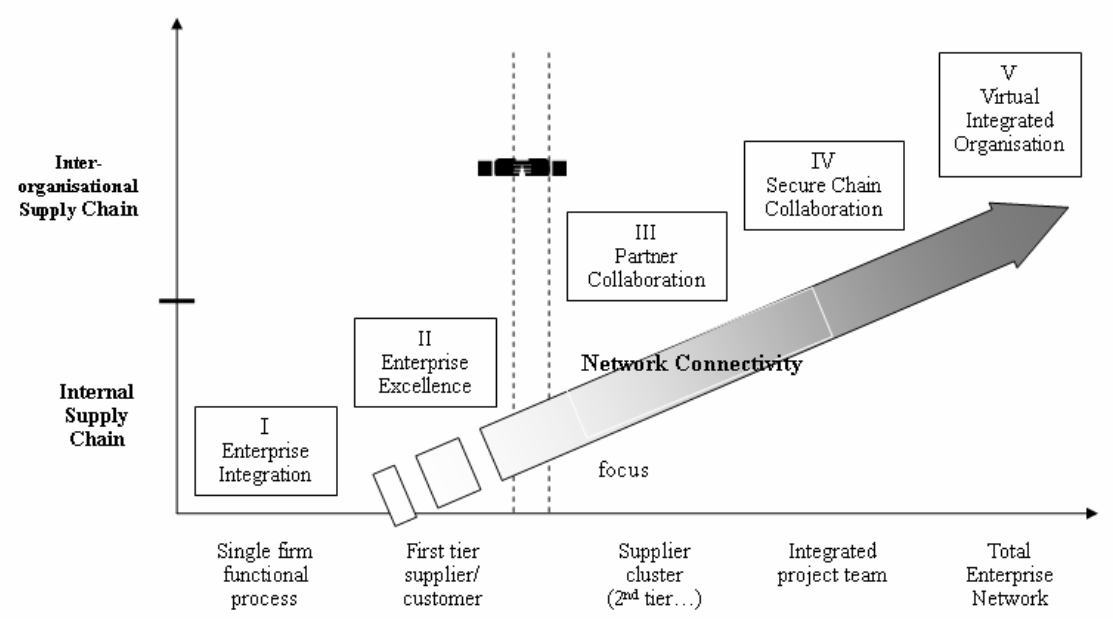

Figure 2 The Five Levels of SCM Evolution in Building Technologies Cluster

In Level 1, the company focuses on intra functional and process improvement with the ERP software systems. In Level 2, the supply chain evolution continues on an internal supply chain basis. The system integration is limited in the first tier supplier/customer with information sharing and basic web based communication. At Level 3, electronic data interchange is introduced. The related suppliers build up the partnerships within a mini supply cluster. At Level 4, the construction project team consists of the supply clusters, suppliers and demand side of the supply chain is organized with the secure web-based SCM information system to manage the network organisational information flow. Level 5, the most advanced stage of supply chain evolution, is where the fully integrated project supply chain is formed. The project supply chain players corporate within a virtual environment which is supported by the information system and other sophistic techniques including e-tendering, four dimensional (4D) virtual reality, 3G or 4G communication, etc. The extent of network connectivity for the supply chain system is increased along with the levels.

E-SUPPLY CHAIN INFORMATION SYSTEM CONCEPTUALISATION

The online 'Integrated Supply Chain Workbooks' published by the Strategic Forum for Construction (DTI: The Strategic Forum for Construction 2003) presents a guidance on how best practice in integration can be applied at different levels of the building technologies supply including defining the procurement strategies, selecting the suitable suppliers and identifying the principle improvement. But these concepts and approaches have been proved to be inadequate to cope with the increasing complexity and requirements of the building technologies cluster and the construction projects it supports, without the deployment of information and communication technology (ICT) (Mohamed 2003). It is therefore necessary to seek to pose the question, which is, what is such a suitable ICT system architecture for supply chain management across dynamic organisational networks for building technologies cluster?

To bring the issues of the systems architecture into focus, it is necessary to understand that the general supply chain management distinguishes between strategic, tactical and operational level decision making aimed at optimising supply chain performance. The strategic level is concerned with such issues as supplier base reduction, the formation of collaborative relationships and supplier development (Gadde and Hakansson 1994). At the tactical level, the aim emphasis is typically concerned with supplier assessment, supplier selection, resource planning, etc. At the operational level, the tasks are more administrative in nature and, for example, related to purchase requisitions, order fulfilment, inventory management, and supply chain team working (Kumaraswamy and Palaneeswaran 2000).

Based on this three level decision making model, a basic web based E-supply chain information system architecture is conceptualized with five focus areas. They are (1) to develop an appropriate supplier/customer database as the information portal for the system; (2) to develop a decision optimisation based supply chain planning mechanism; (3) to develop a supply chain execution mechanism as the management module for the system; (4) to develop a rigorous but pragmatic supply chain/supply chain player assessment methodology; and (5) to organize a knowledge base for the E-supply chain information system and the building technologies cluster. Figure 3 shows a conceptualised diagram for these five components.

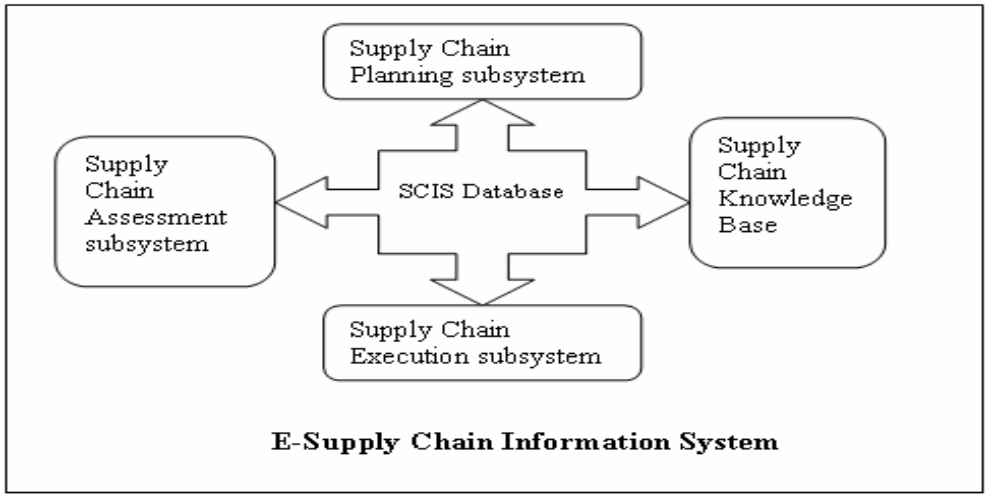

Figure 3 E-supply chain information system five components

The SCIS database will be an interactive information portal for the whole E-supply chain information system. It will support the supplier/product/service searching, the supplier reduction and preliminary partner development. So the SCIS database is at the strategic level. The database will also become the foundation for the electronic data management and the electronic document exchange.

The Supply Chain Planning (SCP) subsystem will be a decision optimisation based subsystem. The responsibilities of the SCP include supplier/customer partnering, supply/demand planning, construction planning, and delivery planning. During this stage, the supply chain will be formed, and also the activities in this supply chain will be designed and clarified. Therefore, the SCP is at the tactical level.

The Supply Chain Execution (SCE) subsystem will play the role as the management centre of the supply chain activities at the operational level. The SCE subsystem will enable the e-marketplace activities deployed in the building technologies supply

chain, such as product introduction, e-procurement, e-tendering, order processing, delivery management, inventory management.

The Supply Chain Assessment (SCA) subsystem will provide the service for assessing and measuring the supply chain/supply chain player performance. It will offer a template-based, data-driven assessment procedure with the specific reporting, actionable diagnostics and value-driven findings. And the Supply Chain Knowledge Base (SCKB) will be the interactive and self-developing knowledge and technology library for the E-supply chain information system.

E-SUPPLY CHAIN INFORMATION SYSTEM FRAMEWORK

According to several surveys about the information systems in terms of usefulness, performance and role in the entire project supply chain (Mohamed 2003; Akintoye *et al.* 2000; Barker *et al.* 2000; Weipper *et al*.2003), some ideas for the expected information system can be summarized as follows:

- All of the project supply chain players can access to the project information with the corresponding authorization right and can communicate with each other efficiently.
- Electronic linkages should be able to change the nature of inter-organisational relationships by raising trust, lowing risk and increasing the level of business process transparency.
- Use of the system should not hinder any technical or managerial or administrative tasks.

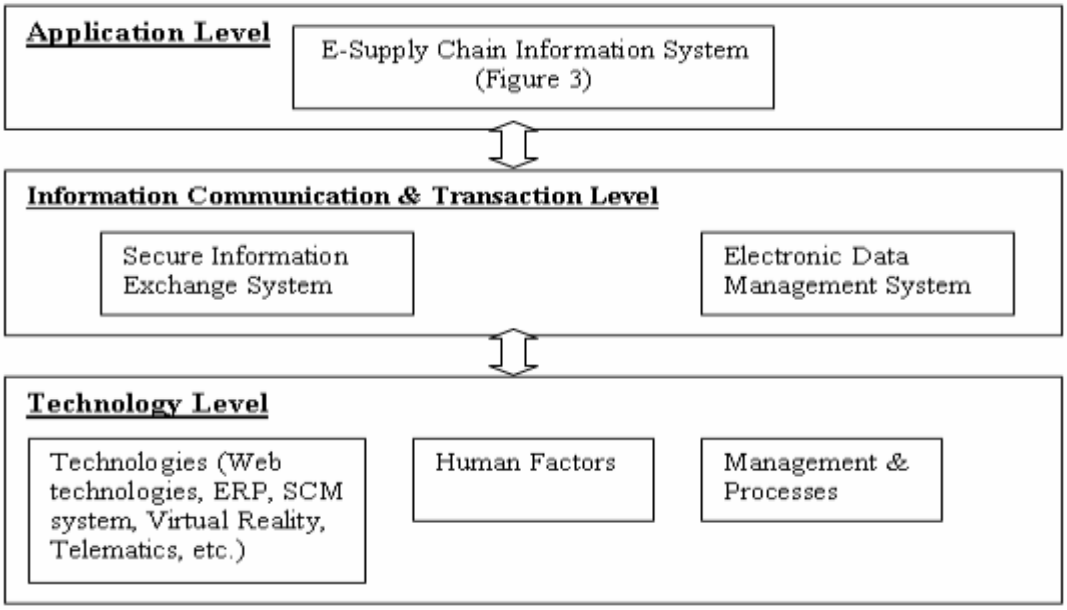

Figure 4 E-supply chain information system framework

Therefore, the web-based supply chain information system is designed to be organised in three levels as shown in Figure 4:

- Application level: applying the technologies; providing the supply chain integration services to users directly and acting as the interface.

- Information communication and transaction level: communicating and exchanging information; capturing transparent information over the systems and users.
- Technology level: offering the basic and primary information and communication technologies together with the management and human issues to support the upper levels functions.

This deployment of E-supply chain within the Building Technologies may be visualised in terms of technology and process road map represented as a wave diagram shown in figure 5. The distribution of the contour of the roadmap is either accelerated or decelerated by various factors such as the four factors shown as linear lines radically distributed across the curves. These lines are factors that determine the rate of e-supply chain deployment.

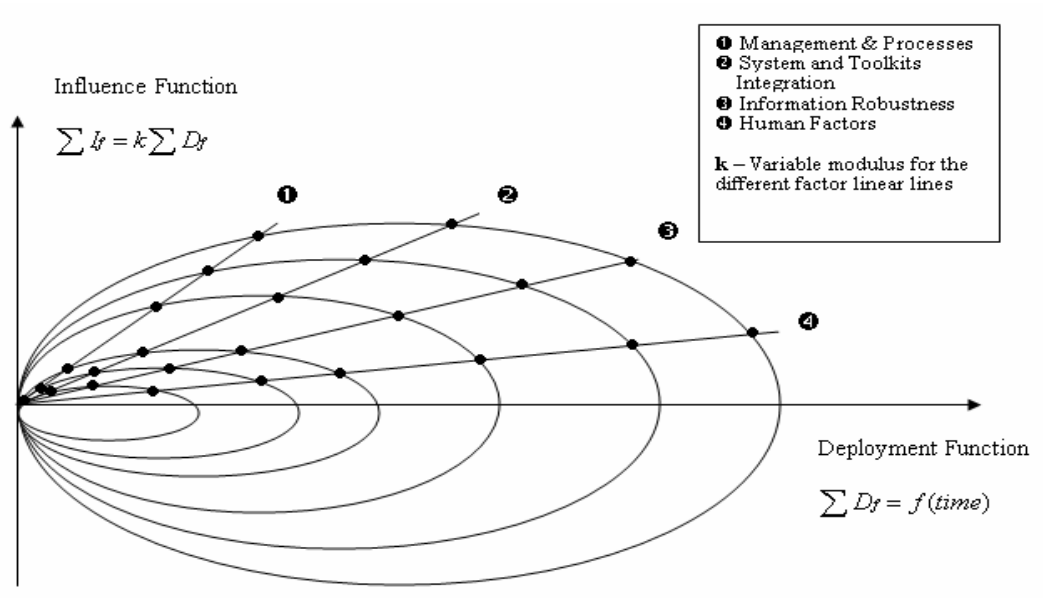

Figure 5 E-Supply Chain Deployment Wave

The four major factors identified in figure 5 are further detailed in table 1, where there are other underlining sub-factors that contribute to the deployment rate.

❶ Management & Processes	❷ System & Toolkits Integration	❸ Information Robustness	❹ Human Factors
▪ Partner Collaboration ▪ Financial Strength ▪ Management Processes ▪ Size & Type of the organization ▪ etc.	▪ System Integration Architecture ▪ User Functional Toolkits ▪ Inter-system communication ▪ etc.	▪ Data Flexibility ▪ Data Reliability ▪ Data Security ▪ etc.	▪ Tradition & Legacy ▪ User perception ▪ Skills & expertise ▪ etc.

Table 1 E-supply chain deployment influential factors

'Management and processes' is the initial and theoretical issue which is normally identified before the development of the system. Then the holistic system architecture and functions will be considered. The information quality is then of utmost

importance in the deployment of the detailed information flow structure leading to the implementation of the system. The system should deal with both standardized everyday routine information with structured form and specific real-time generated information with unstructured form. Furthermore, the information should be fresh without errors within a high security exchange environment. Finally, the disposal of 'human factors' needs the effort from the development of the former three factors to show the practical benefits to change people's mind-set and also improve the system deployment in the next iteration with more available skills, expertise and user perceptions.

CONCLUSION

From all aspects presented in the paper it can be seen that there is an enormous potential for the development of an integrated information system for the building technologies supply chain. While the concepts of supply chain and supply chain management has got the wide awareness in the cluster, application of the advanced ICT supply chain integration information system is still limited. Regarding to the Five Levels of SCM evolution, most of the organizations in the building technologies cluster are at the level of 'I. Enterprise Integration' or 'II. Enterprise Excellence' with the focus on the intra-organizational functions integration. Breaking down the wall between the supply chain players to develop the partnerships with ICT has become the key factor to overcome the fragmentation nature of the building technologies cluster and the associated construction industry.

This paper has outlined a framework for the E-supply chain information system for the building technologies cluster within which the SCM concepts are conceptualized with the integrated ICT aided architecture. The system will be organized in three levels and influenced by four factors. The components within these three levels communicate and collaborate with each other to complete the SCM implementation process. Based on this framework, more detailed E-supply chain information system architecture will be developed with the modelling tools in the next study stage.

ACKNOWLEDGEMENT

We are grateful to Advantage West Midlands (AWM) for funding part of this project. We are especially grateful to Michael Ciotkowski, Frankie York and Neil Walker of the AWM's Building Technologies Cluster Executive Group for their advice on the development of the Supply Chain Database. We are appreciative of the contribution that the members of the AWM Building Technologies Opportunity Group, chaired by George Mash, (see www.advantagewm.co.uk) are making on this project.

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