# AN APPROACH TO E-BUSINESS IN CONSTRUCTION

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A construction supply chain spans over multiple organisations. An organisation, supplier or service provider of a specific project, product or service can belong simultaneously to several construction supply chains. Some organisations along the supply chains establish long-term commitments and ties with suppliers and thus create mutual dependency. E-business is the point where economic value creation and information technology comes together. It enables organisations to connect seamlessly to business partners for all their inter-enterprise processes. The Internet and Web technology have emerged as the most cost-effective driving forces in changing the business relation along the construction supply chains. Construction executives are now aware that information technology is a key strategic factor in value creation over their business processes. This paper makes an analysis of the web-based value chains in construction. It discusses the logics of value at play in e-business. Finally, it explores various types of e-business approaches for construction organisations.

Keywords: construction industry, e-business, value, web.

## INTRODUCTION

E-Business in construction is not just about selling and buying products online, as e-commerce was originally defined. It covers all aspects of relationships with clients, contractors, suppliers, installers, designers, and other partners. It also includes service infrastructure, and multiparty, multidisciplinary (business-to-business) transactions. The Internet and the World Wide Web have dramatically changed the way enterprises do business. E-business, or business processes conducted over the Internet or Intranets, have seen a dramatic increase in just a few short years – but there is still a long way to go especially for small and medium business use of the electronic information standards and Internet technology (Waldt and Drumond, 2002). The construction industry is predominantly made by small and medium enterprises. For instance, in Portugal, the small and medium enterprises were responsible for 72% of the total output in 1998. Small and medium enterprise can not afford the complicated conversion from paper to electronic processes, which required often expensive information exchange technology. However, application of electronic information standards and supporting Internet technology are redefining business processes on an unprecedented scale and pace. E-business is the point where economic value creation and information technology come together. It enables organisations to connect seamlessly to business partners for all their inter-enterprise processes. The Internet

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and Web technology have emerged as the most cost-effective driving forces in changing the business relations along the construction supply chains. Construction executives are now aware that information technology is a key strategic factor in value creation over their business processes.

## RESEARCH OBJECTIVES

Four research objectives were set for the study. These were:

To examine the logics of value at play at e-business

To discuss the value dimensions of e-business

To identify the major application of electronic standards and supporting Internet technology for small and medium enterprises in the construction industry

To present a strategy for e-business adoption in the construction organisations

## E-BUSINES IN THE CONSTRUCTION VALUE CHAINS

The supply chain in construction can be considered as a process of series of activities transforming raw materials into finish products (e.g. roads or buildings) and services (e.g. design or budget) for use by a client irrespective of organisation boundaries (Cox and Thompson, 1998). It includes all those activities associated with transforming goods from raw materials stage through to acceptance of the product or service by the client. Unlike other industrial sectors, the construction industry consists of three distinct but interdependent supply chains, namely: building and assembly; professional services; and materials supply (Cox and Thompson, 1998).

Effective supply chain management involves integrating all supply chain management into one system. An integrated supply chain system is flexible and adaptable. New business processes can be easily automated without a major revision of the original concept. Traditional building assembly value chain, lining up a group of business partners, moves goods and services from suppliers of construction materials and components to contractors and then to clients and finally to the users. That chain created in the past, undergoes substantial tweaking in Web-based business and also the more traditional business engaged in any form of e-business.

E-business is intrinsically task-based: business partners engage in activities such as advertising, brokering, buying, and selling (Preece and Decker, 2002). It affects everyone's role in the supply chain. Each organisation participates as a vendor/supplier in some segment of the global supply chain and acts as a customer in others. Because of the expanded marketing opportunities, e-business increases options available on products and services and speeds the delivery of products and services to the ultimate consumer.

Entire links of the chain disappear in some Web-based value chain. Suppliers of construction materials, components and plant are prime targets for extinction as the manufacturers move to more direct contact with contractors and even clients. Dynamic interaction between links in the chain leads from conventional linear links chains to nonlinear networked forms of business that business writers refer to as value networks, dynamic value constellations virtual extended enterprise, or business Webs (Austin, 2001). However, fitting e-business solutions to the construction supply chains, accurately assessing the costs of modifying the value chain, and building the bottom line must take precedence over pure technological innovation.

## THE LOGICS OF VALUE IN THE E-BUSINESS

According to Porter (1985), the value chain classifies value activities in two groups: *primary activities* and *support activities* (see figure 1). Primary activities cover those activities that play a direct role in the creation of product or service value, while support activities indirectly support the chain as a whole. In a value-chain analysis, business processes are classified accordingly. The value-chain is then analysed by the way they add value and how they help differentiate a firm from its competition, and thus contribute to competitive advantage.

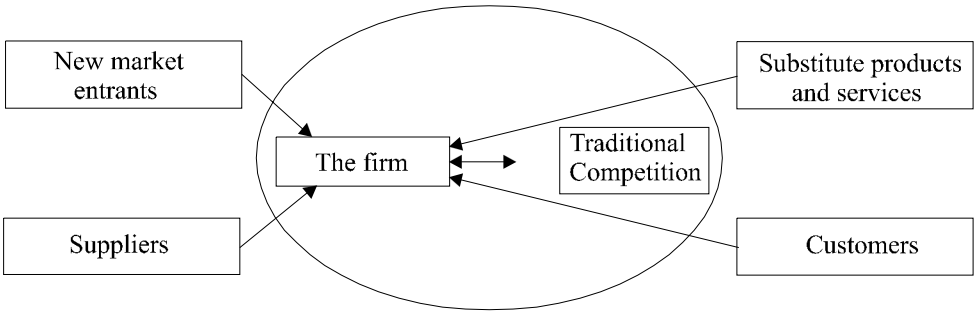


**Figure 1:** The value chain

A value constellation shifts the focus form the actual activities performed by a firm – the value chain – to the activities that should be performed and that customers value (Normann and Ramirez, 1994). These activities form a value constellation that can involve a large number of actors or organisations that provide a particular offering, or set of offerings. This concept has important implications for construction organisations because of the rapid development of e-business and the many new business models that the Web-based services enables. In an e-business setting, a contractor can establish relationships with a number of suppliers (building material and plant suppliers) for managing its supply chain. When e-business technology is used, the setup looks more like figure 2: a functional setting where each enterprise represents itself. Depending on the size of the enterprise, each block may represent from one to hundred of computers. Stored rules can be used to handle most of the transactions. The exchanges are done with Extensible Markup Language (XML) or Electronic Business Extensible Markup Language ebXML using Simple Object Access Protocol (SOAP).

Many e-business models are best analysed as a network of value activities that are allocated to, and carried out by, different actors. For example, electronic market places and virtual enterprises provide advanced value networks examples. However, e-business implies that technology must prove itself in an interactive and distributed context of economic value creation.

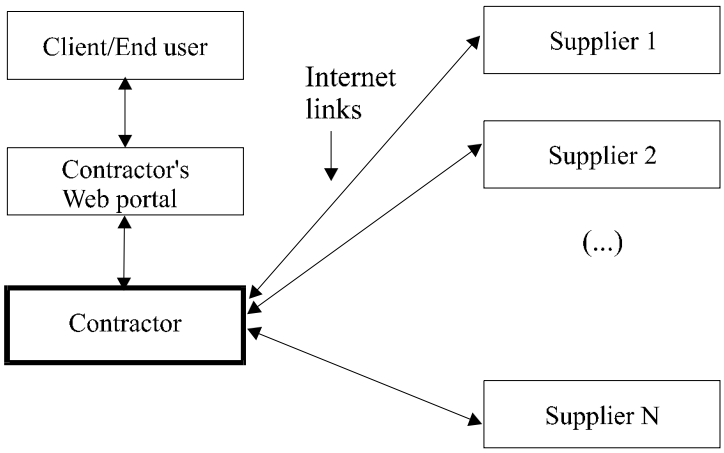


**Figure 2:** Functional decomposition in a Web-based business

Technology push and market pull both play their role in driving e-business forward in the construction industry. So, three different logics of value can be identified as having a great impact on the success of e-business. They are:

*Business logic* takes in account the different roles and business models of the various participants in the supply chain (clients, contractors, suppliers, assemblers) that together define the production and delivery chain setup. As shown above, the traditional supply chain can be reconfigured in many networked ways- one of the new degrees of freedom in designing e-business solutions – reducing the transaction costs.

*Market logic* deals with whether the enterprise can expect clients to be interested and willing to pay for an e-business offering. Additionally, e-business is innovative and therefore imposes changes in clients and suppliers behaviour – and it is well known in construction that innovations present barriers to business partners acceptance.

*Technology logic* refers to whether the technology and e-business needs suffice in terms of functionality, reliability and availability and to whether the enterprise has the required corporate technology competencies.

Although these three logics of value clearly separate issues, they must be aligned worked together for e-business to succeed (Gordijn and Akkermanns, 2001).

## E-BUSINESS BENEFITS

Traditional business theory weighs the cost of doing something by the net benefit it will provide. E-business technology introduces an additional software layer and thus additional complexity, which must be offset against the benefits. Among the most striking benefits of e-business technology is the potential of dynamic business interoperability across enterprise boundaries.

Let's consider e-business technology from a Return on Investment (ROI) perspective. ROI compares the input (investment) with useable output (return). For the most part, investment is defined in terms of either money or time (which, of course, can be converted in money). In context of e-business technology, ROI can be defined as the total benefits that accrue from a given expenditure. According the logics of value discussed above, there are three broad categories of benefits that should be distinguished in the context of the ROI analysis: business value, market value and technical value.

## BUSINESS VALUE

If e-business technology continues to be a driver for establishing an inter-enterprise infrastructure, its business value become obvious, at least in the medium and long term. Some of the medium and long term business benefits to enterprise include:

- Faster time to market with new and improved services
- Expanded service deployment at lower cost
- Vastly improved business agility
- Increased process efficiencies
- Reduced human error due to business process automation

In the short term, because of the geographic dispersion of construction enterprises, businesses can make early strides by making use of e-business technology within the boundaries of the enterprise. Some Enterprise Application Integration (EAI) projects will benefit from "wrapping" existing business services and thus extending their lifecycle.

## TECHNICAL VALUE

From a technical viewpoint, e-business technology has the potential to raise distributed computing to a new level. However, vendor-neutral protocols and vendor-neutral service interface description language, as well as a vendor-neutral standard for registration, publishing and finding services, can indeed form the backbone for an inter-enterprise infrastructure.

In a medium and long term view, a highly standardised enterprise infrastructure leads to a reduction of expenditures. Standardisation will better meet the demand of Information Technology (IT) managers who want interoperability without all the hassles with plumbing together application systems, l*et al.*one implementation and maintenance surcharges.

One of the important characteristics of a business-oriented architecture is the loose coupling between business processes. Loose coupling offers many benefits, most notably higher flexibility. Business services automation can evolve independently without affecting their ability to inter-operate and significantly reduce software maintenance time and costs. The infrastructure then only needs to provide the means to interact with business services. In addition, a business-oriented architecture is a prerequisite for use of services in different environments. Technically speaking it is irrelevant whether a business service is invoked by a Web portal or by a Business Process Management System.

As the e-business technology matures, construction enterprises will see the following benefits:

- Lower integration costs, many attributable to a broad base of public standards
- Increased speed of deployment as a software services industry gains momentum
- Less coding requirements at large, owing to the ability to license more services from third party vendors
- Less internal human resources required.

## MARKET VALUE

E-business enables new business forms that exploit greater levels of interactivity for clients and suppliers, increasing opportunities for uniting business and market logics. So clients and end users can become more directly and actively in value production. In addition, e-business increases a given product's cost efficiency by reducing transaction costs. By exploiting existing client and sales data, enterprises can improve marketing efficiency.

## E-BUSINESS TECHNOLOGY FOR SMALL AND MEDIUM ENTERPRISES

There are two broad types of e-business: e-business used in an Intranet and e-business used on the Internet (Davidson, 2002). E-business once were the domain of the largest companies that could afford the application of supporting technology. Small and medium sized enterprises engaged in e-business when they were forced by their trading partners.

There is widespread agreement that e-business technology must be based on vendor-neutral standards (Jenz, 2002). Software vendors seem to share that view, since recently leading software vendors have joined to form the Web Services Interoperability Organisation (WS-I). Today, one set of standards that are enabling the adoption of e-business by small and medium enterprises is the XML family standards. According to the Gartner Group, in 2003, is expected that over 80% of application-to-application communication over public networks to be conducted using XML and SOAP, a core of Web Services Standards. And, over 75% of documents are expected to be matched with other formats than XML to support a blending of new applications and legacy system integration.

The ebXML a joint project form United Nations/Center for Trade Facilitation and Electronic Business (UN/CEFACT) and Organisation for Advancement of Structures Information Standards (OASIS) heavily uses XML, Public Key Infrastructure, and other Internet standards to promote cost effective e-business applications for small and medium enterprises (Jenz, 2002). The technology used to define documents and databases, information and the software processing it are becoming indistinguishable in regards to the information standards employed to execute mission critical business processes because of XML in general, and now ebXML in the e-business realm. ebXML standards are open, vendor-neutral and relatively easy to implement, which should help construction enterprise to participate in electronic business-to-business (B2B). Over the past two years ebXML has made significant progress and is gaining support from B2B initiatives such as RosattaNet and BizTalk.

Enterprises using ebXML will not only benefit form open standards. They will benefit form the advantages of reuse. ebXML enables the reuse of public business processes definitions as well as business document type definitions. Reuse can also be obtained by enterprises using ebXML solutions to integrate existing legacy systems via Web services. This is possible since during the development of ebXML, there was a significant change in messaging format towards SOAP standards. Several vendors have already made available ebXML Registry and Repository implementations, ebXML Message Service implementations, and Business Process Execution Engines (capable of interpreting ebXML Business Processes Specifications (BPSs).

The value of ebXML is that it meets a critical requirement of a electronic business-to-business infrastructure platform. It enables the coupling of business processes to be "loose coupling". The ebXML collaboration model has been modelled upon current collaboration practices. Since ebXML requires applications to communicate by exchanging XML-encoded business documents, no business partner will have the capacity to lock resources on another partner's system. Another value factor of ebXML it has defined business processes and a formalisation of the semantics of business partner collaboration so that true business process automation becomes possible. ebXML messages are consistent, are based upon well-developed business processes, work with clear business semantics, and allow business to be conducted according to standard or mutually agreed upon practices of trading partners all of this using off-the-shelf software and business tools.

The business processes supported by ebXML are expressed as process models and encoded in XML. All ebXML developed messages are encoded in XML as well. Common business processes were modelled using established modelling standards such as Unified Modelling Language (UML) and stored in a global registry. Business partners register their profiles as well. This consistency and detail enables seamless interoperability.

ebXML is composed of three infrastructure components and several other efforts such as ones focused on document creation, business process definition etc. ebXML infrastructure components include:

- *Collaborative Protocol Profile* (CPP) –defines XML data structures which describe what each trading partner supports, the components necessary to conduct e-business, such as data communications, security, processes, document types, etc. It describes the enterprise in a standard, portable way.
- *Collaboration Protocol Agreement* (CPA) – describes the exact requirements and mechanisms for the transactions that two enterprises perform with each other.
- *Business Process and Information Modelling* (BPIM) – includes specifications for describing a business process in XML. This can include transactions, document flow, binary collaborations, data encapsulation formats, and more.
- *Core Components* (CC) – are set of ebXML schemas, also called components. This schemas contain formats for business data, such as dates, taxation amounts, account owner, exchange contract, and more.
- *Registry and repository* – defines the access interfaces, security and information storage format for any information that needs to be widely, yet securely shared among trading partners or potential trading partners.
- *Messaging* – defines the means to move data between trading partners in a secure, reliable manner. In particular, an ebXML message represents the visible part of the execution of a CPA.

## AN APROACH FOR E-BUSINESS IN CONSTRUCTION

The technology in principle is simple, and encourages the re-use of existing infrastructure. Its application requires a holistic approach that encompasses the business problems to be addressed, and judicious combination of new and old technologies (Castro E., 2002). Some enterprises will have this expertise in house, and some will find out they need to bring experts. In other words, success in the

application of e-business technology cannot be attained without a consulting strategy, regardless of whether these resources are internal or external.

An e-business service may be built using pre-existing programs, whose original designer might not have known about this particular purpose. For example, a contractor can establish relationships with a number of suppliers for managing its supply chain. In this environment, the most probable path is adoption through internal projects first to limit the risk.

Some enterprise don't have a shortage of internal application integration projects that could be used as starting points to build e-business experience. Another potential fertile ground for internal projects is application integration projects stemming from merger and acquisitions or from corporate downsizing.

Significant experimentation by construction enterprise, at least for internal projects is expected mainly because of the potential for high payoff for effort expended. Partial less complex implementations are possible, particularly in the area of inventory management, for instance by using private definition for XML exchanges. Beyond internal e-business deployments, the next rung in the adoption ladder will be in construction enterprises with established trust relationships with suppliers, assemblers and subcontractors. Enterprise-to-enterprise business (business-to-business) can be implemented using ebBXML combined with SOAP. Construction enterprises can reap some of the benefits of ebXML based technology immediately with relatively little effort.

As a first step, standardised business document types can be adopted (for example "Invoice", "Purchase Order"), gradually replacing custom business documents types. Business document types form the lowest common denominator when it comes to exchanging data between two trading partners.

XML-encoded business documents can travel as message payloads over SOAP and ebXML messages, l*et al.*one as payloads of a message queuing protocol.

As a second step to reaping some benefits of ebXML now, public processes can be defined and/or adopted from industry bodies such as RosettaNet. In essence, public business processes define the collaboration of two parties in terms of business transactions and the business document types that are exchanged.

The result of this simple two-step approach will manifest itself in significant productivity gains and improved business agility. Then, the next step, implementing an ebXML-based business collaboration solution will be a snap. A plug-and-play architecture allows modular and incremental investment and development.

Figure 3 shows a functional service view of an ebXML system based on the ebXML Technical Architecture Specification available at www.ebxlm.org. It shows how two trading partners can build their own e-business applications based on ebXML and SOAP.

## CONCLUSIONS

The value of e-business is hard to resist: it is about interoperability, and promises of reaching a big jump in capability with minimal changes and maximal re-use of existing infrastructure. The fact that standards are still evolving should be taken as an opportunity to develop corporate expertise to gain an early competitive advantage. And while adoption of e-business may not necessitate significant changes to existing

infrastructure, the catch is in figuring out where these change lies, particularly at level of the business models and practices. This knowledge can be attained only through experience with related projects.

This paper presents the logics of value at play on e-business and shows the value on e-business adoption. It presents the most promising e-business technology for small and medium enterprises and an approach for e-business adoption.

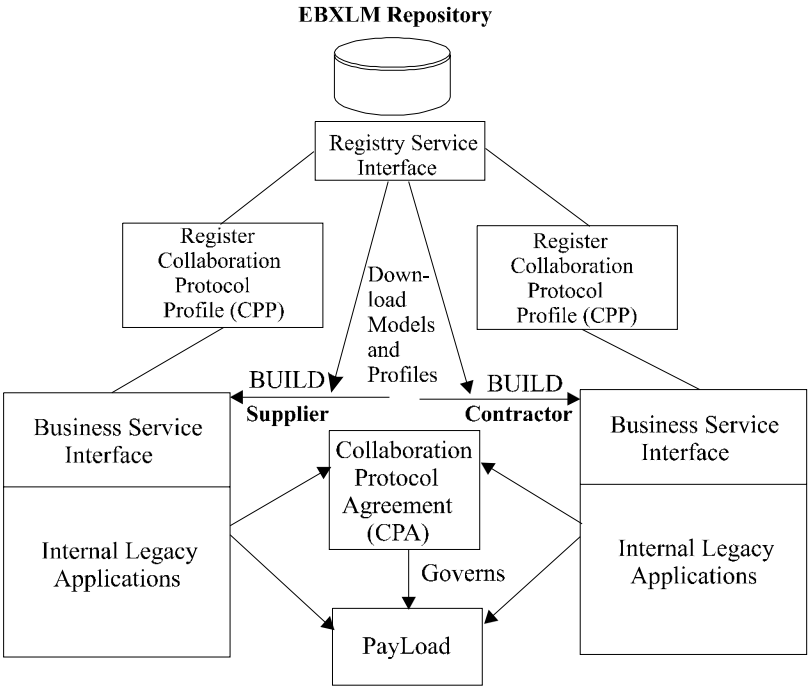


**Figure 3:** An ebXML architecture

Solutions based on ebXML will eventually lead to decrease of licence fees since open and public standards create a naturally more competitive marketplaces. ebXML aims to bring the world of e-business to small and medium enterprises, penetrating the enormous potential in that sector. So it is suited for construction organisations. E-business is of course based on technology, but experience shows that value creation on e-business adoption starts with good business.

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