Chemical Industry Supply Chain Innovation: A Case Study of e-Enablement Practice

Paul D. Denton [1], Kim H. Tan[2], Mufeed Hajjaji [1], Abid Bashir [1]

[1] School of Computing and Engineering, University of Huddersfield, Queensgate, Huddersfield, West Yorkshire, HD1 3DH, United Kingdom
p.d.denton@hud.ac.uk, m.hajjaji@hud.ac.uk, a.bashir@hud.ac.uk
[2] Nottingham University Business School, University of Nottingham, Jubilee Campus, Wollaton Road, Nottingham, United Kingdom, NG8 1BB, United Kingdom
kim.tan@nottingham.ac.uk

Abstract

Today, there exists a shift towards the adoption of sophisticated supply chain integration and e-commerce techniques by leading global enterprises. Supply chain performance improvement initiatives strive to match supply and demand thereby driving down costs simultaneously with improving customer satisfaction levels. A central element of this move has been the evolution of e-marketplaces or trading hubs and portals, which it is suggested, can provide effective mechanisms for achieving synthesis between a wide range of collaborating partners and systems. To succeed in these environments, enterprises need to be highly capable of process management and systems integration, but problems associated with 'complexity and scope', undertaking 'cost/benefit analysis' and 'value proposition evaluation' remain. The industrial case study and academic research briefly presented within this paper, highlights a favourable implementation example of how contemporary business requirements were outpacing available supply chain research and software tools. The revised supply chain model developed through the case study was considered to offer a holistic approach with greater speed of execution, reduced administration costs and improved value-added services. This paper reports findings revealed during the implementation of an e-marketplace integration project by a renowned chemical logistics enterprise.

Keywords: Chemicals Industry, Supply Chain Management, E-marketplace.

1. Introduction

As the landscape for business has been amplified from local to global levels for many contemporary enterprises, the need to develop closer and more integrated links between internal operations, customers and suppliers, has become an increasingly important key. High proportions of enterprises are now organised as networks of manufacturing, assembly and distribution sites, which may be scattered around the world. Together with customers and suppliers, these networks, which we often refer to as 'Supply Chains' affect crucially both customer service and the total cost to the customer of products and services. The use of strategic Information Technology (IT) is often seen as an 'enabler' for supporting this aim, but significant problems related to efficient selection and implementation can emerge. For one such UK enterprise, facing a new directive of contractually enforced e-marketplace adoption by a key supplier; it encountered the necessity of rapidly navigation the management methodology and technology landscape to deliver a new and innovative supply chain solution. It was anticipated by the enterprise management, that a targeted 'Supply Chain Integration Project' would be necessary to not only deliver e-marketplace operational compliance, but also provide some degree of positive Return on Investment (ROI) from potentially wide-ranging supply chain impacts and efficiency improvements. The findings revealed within this paper demonstrate a novel approach to e-enablement of an extended supply chain with specific regard to e-marketplace connectivity, building on possible 'breakthrough changes' recognised by Gunasekaran et al, [1] with respect to Electronic Commerce (EC) adoption, but also the developing e-enablement approaches detailed in [2] and [3]. At the time of project initiation, it was considered by the enterprise that this project would be unique in terms of the technological challenge presented and the nature of the unified supply integration approach required.

The case study enterprise is situated regionally throughout the UK and is one of only a handful of British companies that offer chemical marketing and distribution services to both industry and end consumers. It had developed a range of distributor agreements and a wide range of commodity and speciality products, with new areas being established continuously. Whilst it held a turnover of around $700 Million, it had recently recognised that strategic partnership and supply chain issues must be considered further if the enterprise was to retain a competitive edge and high-share within its existing markets. The enterprise therefore embarked on an initiative to strengthen its key business partner relationships and implement new Internet-enabled supply chain systems to improve efficiency and reduce cost. This strategy was two-fold:

i) to further improve its Internet sell-side channel to maintain its current competitive advantage, and
ii) to rapidly provide supplier connectivity through an industry standard e-marketplace to reduce operational costs and safeguard its valuable distributor agreements.

At the time, the enterprise employed approximately 1,500 staff across 18 sites, with its distribution depots organised within a hub and spoke configuration. Within the organisation, its IT capability was predominately supported in-house and based upon: a centralised Baan Enterprise Resource Planning (ERP) system; and an integrated Internet-based shop front for a limited product range; Electronic Data Interchange (EDI) connectivity through industry standard EDI software; an IBM document management system; and a Cognos business intelligence suite. The programme was driven by the company's Commercial Director, with assistance from the principal author of this paper, and held wide support from the enterprise's other board members. The enterprise had a long operational history in the Chemicals Industry and over time had established valuable relationships with its supply chain partners and industrial bodies. The initial phases of the project are now complete and further development work is in progress.

2. Background

As a precursor to any project definition or requirements specification the enterprise had to develop improved understandings of the potential commercial opportunity and leading-edge research related to the wide scope of the perceived project. These comprised approaches to integrating enterprise supply and demand; typologies of e-marketplaces; and potential benefits and issues. A key concern for the enterprise at this project conception stage was that the implementation would be too costly in terms of finance and resource, may prove technically unachievable, and carried the risk of irreparably damaging supply chain relationships from potential project failure.

2.1 Supply Chain Management (SCM)

SCM is recognised as a pre-eminent concept by which enterprises can make instant improvements to their business strategies [4] Moreover, enhancements to supply chains in terms of improved product quality, faster customer response and greater agility, can provide significant marketplace differentiation and increased levels of competitive advantage. Supply chain performance improvement initiatives strive to match supply and demand thereby driving down costs simultaneously with improving customer satisfaction levels. First step changes to optimising enterprise logistic processes have relied upon concepts such as BPR, Just-In-Time (JIT) and Total Quality Management (TQM) making them faster and more agile [5]. The implementation of SCM techniques externally, as a second step, should lead to

enhanced cost saving opportunities as the whole supply chain can be considered and optimised. Holistic mastery of process is one fundamental element of a successful supply chain, however the enactment of traditional functional systems needs to be re-evaluated in the light of recent IT and communication technologies and in particular the rapid growth of Internet-based EC [6]. The adopted use of commercial ERP systems can facilitate some of the above capabilities. However, it is suggested by Kennerley and Neely [7] that deployments of these all-encompassing business management applications have fallen short in delivering all of the various promises they make and may even place constraints on change. Over the last few years, considerable efforts have been made, both by industrial and academic communities, to investigate and develop new holistic models of enterprise and supply chain systems. These not only build upon previous internally focussed ERP systems, but also recognise outwardly facing SCM imperatives and address changing EC trends. Nowadays 'transactional' ERP systems are routinely implemented with additional Complementary IT Systems (CITS), such as Customer Relationship Management (CRM), Advanced Planning and Scheduling (APS), EC, Data Warehousing and Business Intelligence, to provide extra business support in terms of superior customer interaction, supply chain control and effective management reporting [8]. However, the problems of effective and latent SCM integration, collaboration and performance measurement often remain [9]. As such additional emphasis is now being placed upon new Internet-based approaches designed to support low cost and improved supply chain partner integration. To better consider its comparative position, the enterprise compared itself against the continuum provided in Figure 1. Whilst, it had in place a number of isolated and point-to-point approaches with 2nd generation positioning, it had limited experience of higher e-marketplace connectivity and end-to-end supply chain integration, representative of newer generations.

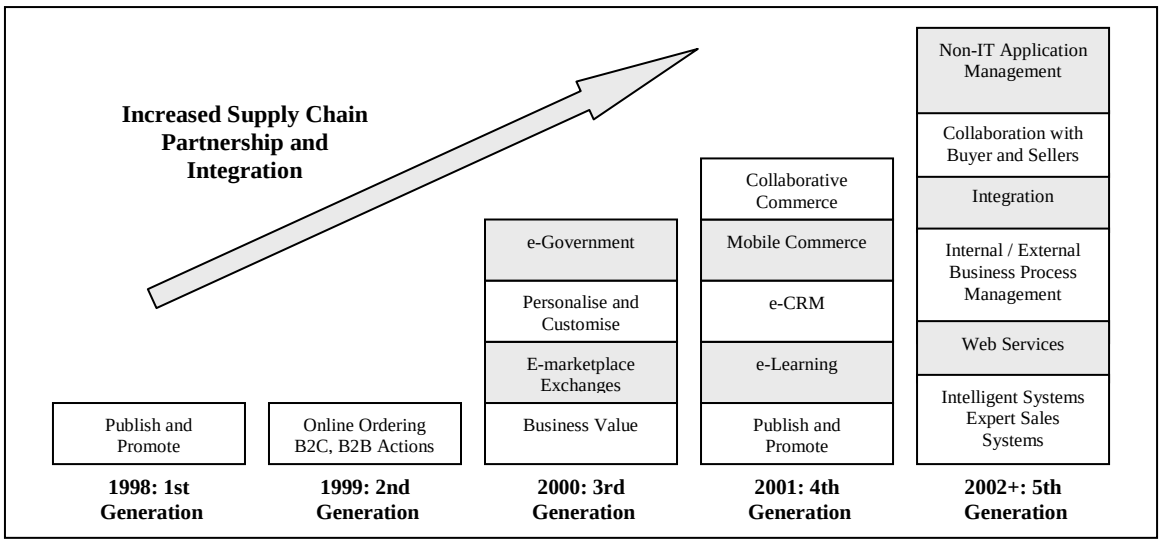


Figure 1. Key Drivers for B2B E-Commerce [10].

Within the context of a Business-to-Business (B2B) Internet software market estimated at $7 to $10 Trillion [11], there can now be seen to be a diverse range of business and software application models, which cover sell-side, buy-side, exchange, and collaborative commerce transactions. Within the context of this paper, primary consideration is centred upon 'e-marketplaces' or trading hubs, which facilitate the many-to-many exchange of business documents such as purchase/sales orders, despatch notes and invoices, etc. between enterprises within a single industry or industrial segment. Whilst e-marketplaces have been around for more than five years, it is only recently that the cycle of inflated expectations and

trough of disillusionment; have been replaced by realistic evaluations and the potential plateaus of profitability. Key business benefits are typically perceived as improved transaction cost, enhanced data quality and greater business responsiveness or latency.

2.2 What is an E-marketplace?

Today enterprises are using IT as an enabler in reaching global markets. IT enables enterprises to create e-marketplaces that bring together large numbers of buyers and sellers; providing sellers access to new customers, facilitating the automation of business transactions, and reducing transaction costs for all the stakeholders [12]. There exist various definitions of e-marketplaces, for example Popovic [13] has defined an e-marketplace as 'a virtual online market where buyers, suppliers, distributors and sellers find and exchange information, conduct trade, and collaborate with each other via an aggregation of information portals, trading exchanges and collaboration tools'. An e-marketplace is also seen as an 'Internet-based solution' [14] that is innovated to facilitate the linkage between buyers and sellers in buying and selling products and services in the marketplace. Other conceptions regard e-marketplaces as web-based systems that allow business transactions to be automated, as well as trading and collaboration between business partners. In additional literature, other researchers such as Mahadevan [15]; Brunn et al [16]; Kaplan and Sawhney [17], conclude that e-marketplaces can further provide three value-added mechanisms, namely:

a) e-marketplaces can have a large pool of buyers and sellers;
b) buyers and sellers can be matched and negotiations on price take place on a real-time basis; and
c) a neutral position allows buyers and suppliers' trust to be ensured.

2.3 E-marketplace Classifications

An e-marketplace may be organised in many different ways. Popovic [13] further categorises e-marketplaces according to the user focus and the ownership structure. Figure 2 shows three categories of e-marketplace. A number of these authors recognise that e-marketplace providers deliver an effective value proposition through greater accessibility, improved marketing intelligence, and reduced transaction costs. For example, a consortia e-marketplace detailed with Figure 2, could allow companies to find new suppliers and buyers more easily and in a broader selection of choice. The whole supply chain can be performed more efficiently in a way that automated the activities that are involved in a procurement process. Moreover, e-marketplace trading is viewed as a collaboration process instead of transaction process. In the competition of 'value chain versus value chain' instead of 'company versus company', Christopher [20] proposed, the collaborative e-marketplace will empower companies to improve the business performance in a transparent market environment. It can be used as a strategic weapon to gain greater success for the business, reduce cost, increase new product time to market, increase the flexibility, and improve the quality of products or service in order to improve customer need and increase customer satisfaction. Some of the current solutions, such as Ariba, Covisint, and Exostar are developed by software vendors in order to help in information exchange in business-to-business commerce [21]. These software tools enable seamless supply chain information sharing across companies. Jutla et al. [22] identified three success factors for e-marketplaces, namely functional factors, strategic factors and technical factors. Functional factors focus on the user community, the product customization and the negotiation support. The strategic factors focus on brand, customer, marketing and outsourcing. The technical factors concentrate on the response time and reliability.

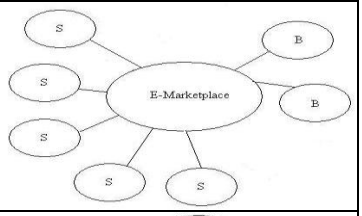
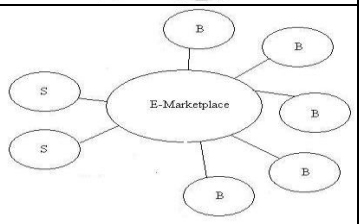
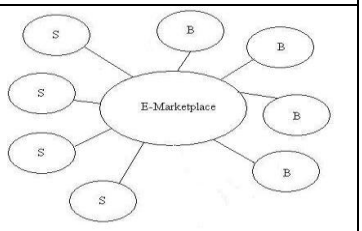
User Focus Structure	Characteristic	Example
Buyer-driven	Usually consists of a limited number of buyers, they form the buyer-driven e-marketplace taking advantages of both effectiveness and efficiency of e-marketplace to manage and reduce the complex process of procurement.	
Supplier-driven	Supplier-driven e-marketplace usually consists of few suppliers, normally one or more number of suppliers own and manage the e-marketplace. Producers with dominant market share or proprietary products are most suitable for this model. The model is also suitable for suppliers that serve a large number of small and fragmented buyers [18].	
Third party-driven	Third-party driven e-marketplaces are neutral intermediaries that allow buyers and sellers to exchange between each other. For example, a consortia e-marketplace is usually founded and owned by a small numbers of participants that have large domination in their industries. In a consortium e-marketplace, the founders are mainly seeking reductions in the cost of conducting business with current business partners as well as other collaboration benefits, and the value proposition is emphasized on the benefit of enabling large buyers or suppliers to transact with their established business partners online through the provision of direct material procurement functionality [19].	 Key: S = Supplier B = Buyer

Figure 2. Classification of E-marketplaces.

2.4 E-marketplace Benefits and Problems

With the development and functionality of e-marketplaces advancing at pace, enterprises are now investigating in greater depth the value proposition of connectivity and trading through e-marketplaces. With unreasonably high expectations, now replaced by realistic benefits evaluation, ROI appraisal, capability assessment and growth forecasting; there can be seen to be developing research within this area [23, 24]. However, Das [25] comments that it has been difficult, and sometime impossible, to perform impartial comparison and effective evaluation of 'e-providers' prior to the adoption of their solutions. Derived e-marketplace benefit and the definition of the user 'offer' are often readily wrapped up in sales speak and functionality terminology. Strategic enterprise goals differ widely, ranging from simple technical purchase order processing and invoice accounting, to high-level business integration and the delivery of supply chain and order fulfilment processes. The success of the e-marketplace solution requires robust and thoughtful approaches, which put the focus on the wider operational implications of adoption, not solely financial. Standing et al, [24] comments that e-marketplace provide wide ranging benefits and dynamics other than; procurement cost reduction (cost strategy), superior service (differentiation), or as a means of streamlining procurement channels (focus). The supply chain aspects of e-marketplaces should involve economic, relational, service and community benefits. Benefits can be purely finance related, but also intangible such as higher relationship confidence, potentially giving order preference to a supplier on not just quality, speed and price criteria alone.

3. Case Study Implementation Processes

The enterprise embarked upon its 'Third party-driven' initiative (Figure 2) with the Commercial Director establishing a project team, led by a senior departmental IT manager, and comprising additional sales, distribution and procurement support. With a fixed budget and timeline in place the first phase of the project was to undertake an external business review and best practice analysis within the industry. Though the marketplace for Chemicals was valued at $500 Billion in Western Europe, with a predicted growth of 1.9%, in recent years a downturn in UK manufacturing output was creating significant sales and financial pressures for the Industry. The Chemicals Industry was considered to be unique in its structure and operation, namely because of two facets, the Industry typically exhibits a high degree of intra-Industry buy and sell activity, with products being inputs to many processes; and, chemicals are used within 95% of all industries, including agriculture, aviation, electronics, manufacturing and service. From this initial review, findings from the Chemical Industry were reported and analysed internally (Table 1). Whilst the enterprise had previously tried to maintain a full service and cost effective market position, it was recognised that given structural industry changes, it would now have to become markedly more defensive and responsive to existing business relationships. With this strategic importance now being placed upon service and supply chain improvemen the project team felt that a large emphasis should be placed upon offering new and improved e-services for customers and forging closer links with key suppliers.

Industry Characterisation	Industry Issues
• Mature European, North American and Japanese markets, with rapid growth potential in Asia and South America. • Highly capital intensive that can exaggerate economic cycles. • Exhibit a high local cost base through fragmentation, legislation, complexity and large plant size. • Structural shift from bulk to higher value-added products. • Internal focus is too high to the detriment of external customers. • Poor integration of IT systems and functional alignment. • Poor SCM understanding and activity is localised in one part of the value chain.	• Globalisation: Far East competition, elimination of trade barriers and overseas market development. • Overcapacity: Cyclicality, cheap commodity competition and lower input costs. • Environmental: Changes to health and safety and environmental legislation. • Advances in technology: Changes in production technology. • Shareholder and customer demands: New quality and service requirements. • Diversification: More suppliers trying to ascend the value chain. • Portfolio concentration: Many enterprises have too many non-core businesses. • Cost Reduction: Far East competition.

Table 1. Chemicals Industry Characterisation and Issues.

With a large proportion of the enterprise's products and services highly dependent upon a small range of raw materials sourced through complex, but potentially lucrative distribution agreements, it was envisaged by the project team that a risk assessment should be undertaken. Due to the pressing nature of the project, the enterprise Board, decided that only a basic investment appraisal should be undertaken, as the risk of losing key supplier distributor agreements by not complying with supplier e-marketplace connectivity requirements could easily outstrip the allocated $200,000 budget and 10-month timescale. The key project elements comprised:

***1. Sell-side*:** Expand the functionality of the enterprise's existing fully integrated Internet shop front capability to that of a partner self-service portal where clients could better manage their

own accounts and access further value-added services such as Product Specifications, Technical Data, Manufacturing Safety Data Sheets (MSDS), Certificates of Analysis (CofA) and electronic formal business documents such as Sales Orders, Delivery Notes, Ship Notices and Invoices.

2. Buy-side: Electronically connect to the Internet-based Chemicals Industry Elemica (www.elemica.com) e-marketplace for business document exchange to strength supply chain partnerships, reduce administration costs, improve cycle-times and establish a trading model which could be extended to many other key suppliers. Achieving connectivity in this way would assist in the maintenance of a global presence and recognition as a world-class enterprise.

Once the strategy had been formalised and approved by the board, the project was transferred to the project manager for implementation. The delivery of the two project phases would be sequential and involve the contracting of a technical Baan ERP integration specialist, due to internal resource and technical expertise limitations. Within the initial four months of the project the Sell-side development was nearing completion, at budget and on time. This phase now married together, user access functionality within the existing Internet shop front with Baan ERP product data and electronic documentation within the enterprise's IBM OnDemand documentation system. With pilot implementations planned with the enterprise's internal business analyst team, development efforts were now centred upon the Buy-side phase. After industrial review, the chemical e-marketplace Elemica was chosen as the trading hub of preference due to its growing presence and existing number of major Chemical Industry company founders.

Elemica was developed by 22 of the leading global chemical companies and provides real-time value to buyers, sellers and service providers in the chemical industry by establishing a single, global, neutral network for secure information sharing within pre-established chemical trading partnerships. Members electronically connect to the Elemica Network via a single connection, using established CIDX ChemXML industry standards or a series of proprietary translations designed around user specific ERP systems. Hence their adage 'Connect Once, Connect All'. Additional benefits to be acquired comprised; the removal of redundant inventory for improved forecasting, automation of slow and manual processing of many routine transactions, optimisation of complex logistics networks, and the improved management of unwieldy documentation flows. The Sell-side phase was undertaken by the existing project team and formed three incremental parts:

i) Purchase Order Management,
ii) Direct Customer Deliveries, and
iii) Purchase Invoice Processing.

Additionally, an Elemica e-Readiness Assessment was completed, Contractual Terms signed and a Technical Architecture Specification developed (Figure 3). This highlights the complexity and scope of transferring computer files between partners in a reliable and secure manner. Although Elemica provided advice upon infrastructure requirements, the location of suitable and scaleable application software to undertake XML data translation and time-bound workflow management was problematic. Academic research [11, 26] and software vendor investigation, together with further supplier discussions, revealed only two appropriate applications to be suitable at the time. These comprised Microsoft's BizTalk and WebMethods B2B Gateway software. Whilst the Microsoft offering was only in the early stages of development, at its list price it was considered cost effective, it already had

availability of pre-defined ChemXML business document standards and an application development kit for implementing the RossettaNet Implementation Framework (RNIF) for Internet-based electronic transport. RossettaNet can be seen as a consortium driven standard, which has been established to share business processes and information electronically.

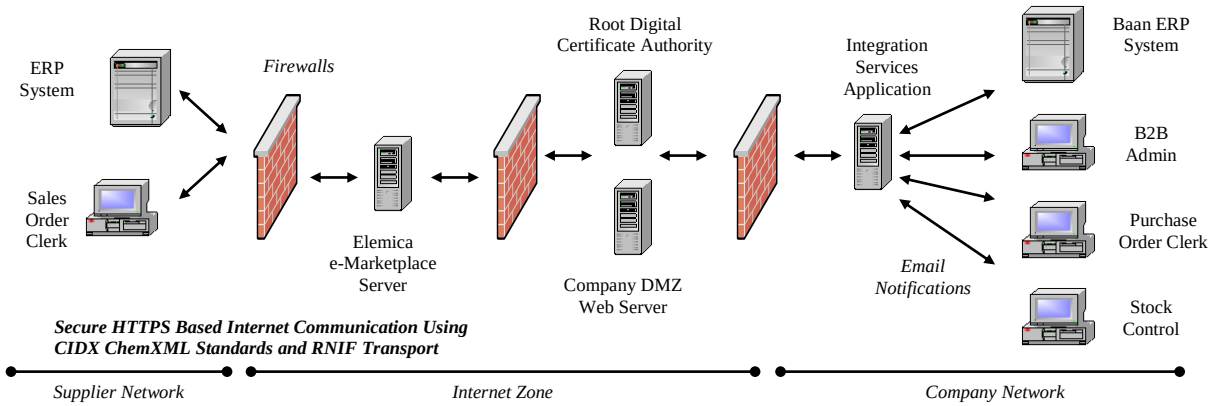


Figure 3. Elemica Technical Architecture Overview (Company Provided).

The WebMethods product set was much more established, but its modular nature and pricing structure was deemed too financially costly for the allocated budget. As such the BizTalk software solution was acquired, a test environment developed and a pilot trading partnership agreed with a mature Elemica and enterprise supplier. The initial pilot process comprised a number of agreed business scenarios for a set product range, delivering into a single distribution point rather than the option for direct customer deliveries as in part two. Initial work comprised developing Baan ERP routines for integrating Purchase Order / Invoice data and, connecting the BizTalk development solution to Elemica's test environment. Whereas the Baan ERP work was completed successful, expertise limitations within the emergent BizTalk product set and the complex technical architecture quickly arose. After a project review, the contracted specialist was released and replaced by an external consultancy firm specialising in BizTalk integration. Whilst this change had wide implications upon cost and time, work was quick to start again and progress re-achieved. Now within the wide industrial landscape, pressure was building from other major suppliers to the enterprise, to plan for subsequent Elemica connectivity and e-marketplace expansion. Despite issues regarding the procurement of suitable and secure digital certificates, internal firewall safety, and investigations to confirm the legality of electronic invoices, testing was scheduled with a delay of three months (Figure 4).

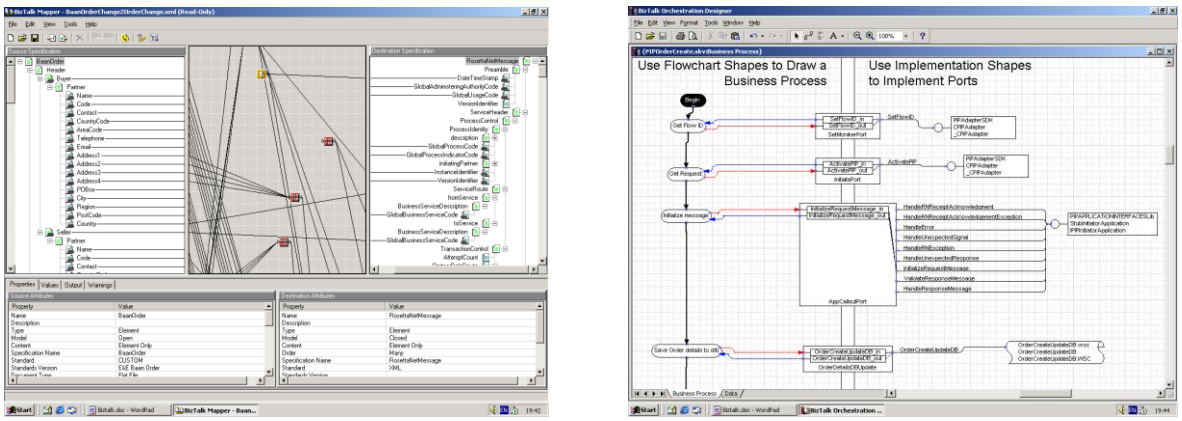


Figure 4. Data Mapping and Business Process Automation.

Structured testing was undertaken with the pilot supplier's European Headquarters, working through the range of previously agreed business scenarios. After internal training was delivered, the new application finally went live, four months late and at one and one-half times the budget. Despite the delay and the additional incurred cost, the enterprise was considered to be the first to market within this integration field and had gone a long way to maintaining the future of its established supply chain alliances.

4. Supply Chain Enablement

The revised supply chain model was considered to offer a holistic approach with greater speed of execution, reduced administration costs and improved value-added services. From the initial placement of a sales online order and automatic email confirmation, daily Distribution Requirements Planning (DRP) requirements would generate firm purchase order requirements for suppliers. Purchase and stock control staff would then release the supplier orders through the Baan ERP, triggering the automatic transfer of appropriately assigned products through the Elemica network. With the service level agreement, defined with the Elemica contract, a confirmation response or changes to delivery date, quantity or price would be returned within eight working hours. Internally to the enterprise, this response would be converted into internal email notifications and distributed to appropriate staff. Once the goods had been despatched, the supplier would transfer ship notice and invoices through Elemica and in turn the enterprise would then make its own available, together with further product information for the customer, within the Internet-based portal (Figure 5).

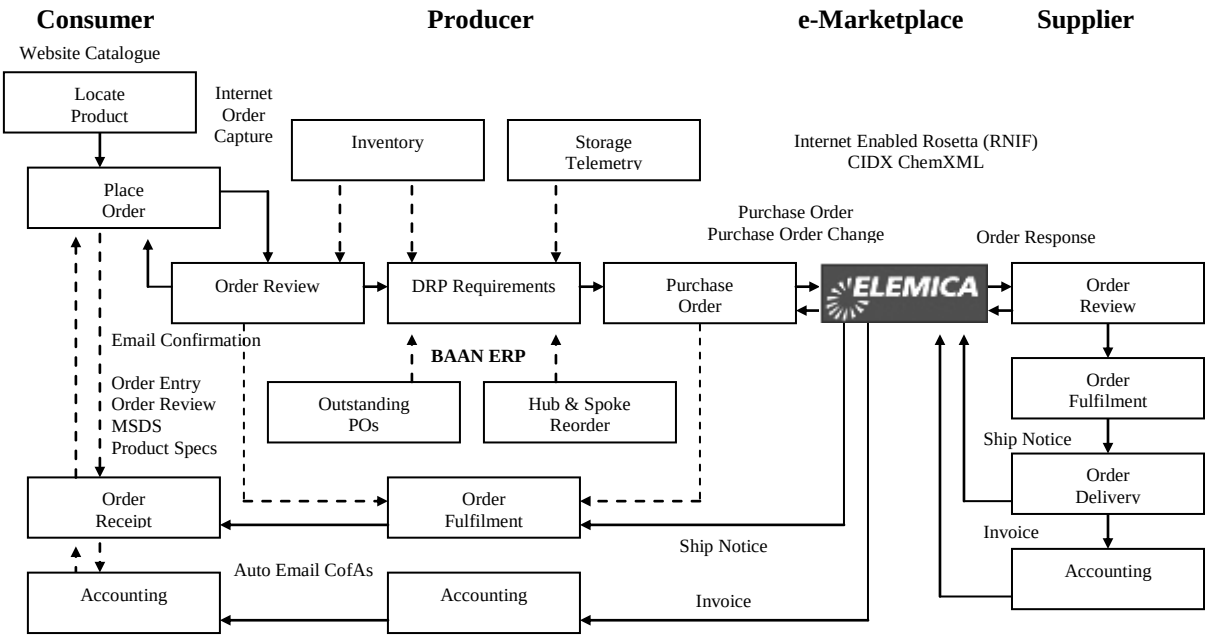


Figure 5. E-marketplace Solution Architecture Overview.

The developed solution had successfully implemented the concept of paperless order processing, while at the same time dramatically reducing the administrative burden for paperwork and error potential. Through automatic invoice reconciliation personnel requirements had been significantly reduced. The whole project had been a significant challenge for the organisation, but it had created a platform for future development and consolidation.

5. Summary and Conclusions

The academic research and industrial case study briefly presented within this paper, highlights a favourable implementation example of how contemporary business requirements were outpacing available supply chain research and software tools. At the time the enterprise had to balance a high degree of supply chain partner pressure with that of technical uncertainty and first-to-market risk. While it is difficult to fully quantify the financials of the project and estimate the cost of undertaking no improvement actions, the real cost of investment per initial transaction may be considered in hard financial terms. Within the first six months of operation, approximately 500 transactions were completed between 200 customers and 2 Elemica connected suppliers. This required an investment of around $300,000 and $20,000 operational costs per year for an annual return of $40,000, leading to a negative ROI figure of over 85% loss. Despite the issue of implementing complex, technically uncertain and business critical applications, the enterprise managed to satisfy supply chain partner expectations, safeguarding around $60 Million turnover, and in the process learning many lessons:

- New solution prowess can be achieved, but always at a substantial cost.
- Emergent technology carries a high-degree of inherent risk. Despite vendor claims, not all requirements can be meet through new applications software.
- Effective Internet security can be beyond the means of even large international enterprises.
- No system or trading partnership is standard. The second supplier connection had differences.
- Whilst the drive to connectivity was problematic, once achieved it allowed for more equal partnerships to develop and financial gain to be shared.

In consideration of Jutla et al.'s [22] factors for e-marketplace success, (strategic functional and technical factors) the following conclusions can be made:

Strategic: From the delivery of the project, the enterprise could now better project its brand to partners through the e-marketplace. Recognised as a leading-edge distributor, with proven capabilities, would allow it to strengthen other supply chain relationships and realise further connection opportunities with additional customers and suppliers, further driving down automated business transaction costs.

Functional: Scheduling and procurement staff would now have increased process efficiency enabling them to concentrate further or negotiation and cost reduction. Product ranges would now be monitored more closely to ensure compliance with the e-marketplace configuration.

Technical: With the e-enablement of the supply chain, the responsiveness of the process and order fulfilment cycle was much improved, reducing the negotiation period from days to hours. Business transaction data accuracy would be improved due to the rigid structures employed by the IT solution. Reliability and demonstrated repeatability of process was an issue within the initial pilot project phase, but this was increasing over-time.

In summary, the authors consider enterprises facing similar issues should respond closely more to tactical business imperatives until they can develop their IT infrastructures to effectively deliver more strategic and technically ambitious projects. To do so, enterprises should focus upon reviewing strategic priorities, balancing supply chain pressures and addressing any opportunity to radically reduce cost, in the first instance. In this way, they should then be in a better position to manage risk and hold the financial and skilled resources to progress quicker in the longer term.

Today, Elemica has 1,250 connected companies with 10 Million transactions totalling $30 Billion per annum (www.elemica.com). It has now moved to simpler web connectivity and online Collaborative Planning Forecasting and Replenishment (CPFR) system provision.

6. References

1. Gunasekarana, A., Marrib, H.B., McGaugheyc, R.E., Nebhwani, R.D., 2002. E-commerce and its Impact on Operations Management. *International Journal of Production Economics*, 75, 185–197.
2. Goutsos, S. and Karacapilidis, N., 2004. Enhanced Supply Chain Management for e-Business Transactions. *International Journal of Production Economics*, 89, 141–152.
3. Nurmilaakso, J-M. 2007 Adoption of E-business Functions and Migration from EDI-based to XML-based E-buiness frameworks in Supply Chain Integration. *International Journal of Production Economics*, 113, 721-733.
4. Fisher, M, L., Hammond, J. H., Obermeyer, W. R., Raman, A., 1994. Making Supply Meet Demand in the Uncertain World. *Harvard Business Review*, May/June, 83-93.
5. Mason-Jones, R., Naylor, B., Towill, D. R., 1999. Lean, Agile or Leagile: Matching Your Supply Chain to the Marketplace. *Proceedings of the 15th International Conference on Production Research*, 1, 593-596.
6. Kehoe, D., Boughton, N., 2001. Internet Based Supply Chain Management. *International Journal of Operations and Production Management*, 21 (4), 516-524.
7. Kennerley, M., Neely, A. 2001. ERP: Analysing the Impact. *Journal of Integrated Manufacturing Systems*, 12, 103-113.
8. Denton, P. D., Little, D., Weston, R. H. Guerrero, A., 2007. An Enterprise Engineering Approach for Supply Chain System Design and Implementation. *International Journal of Services and Operations Management*. 3 (2), 131-151.
9. Denton, P. D., Tan, K. H., Little, D., Bonner, J. V. H., 2007. A Three R Approach for Supply Chain Business Intelligence. *Proceedings of the 19th International Conference on Production Research*. Valparaiso, Chile.
10. Turban, E., King, D., Lee, J., Viehland, D., 2006. *Electronic Commerce: A Managerial Perspective*. Pearson Education International.
11. Ho, P., Trappey, A. J. C. 2004. DES: Use of a XML Hub Approach for the Aerospace Industry, *International Journal of Technology Management*, 28 (2), 227-242.
12. Singh, M., Thomson, D., 2002. An E-Procurement Model for B2B Exchanges: An Australian Example. *15th Bled Conference on eReality: Constructing the eEconomy*. Bled, Slovenia, 17-19 June.
13. Popovic, M., 2002. B2B e-Marketplaces. *European Commission's Electronic Commerce Team*. (Information Society Directorate General), Brussels.
14. White, A., Daniel, E., 2004. Electronic Marketplaces: An Empirical Study in the UK Healthcare Sector. *International Journal of Electronic Business*, 2 (6), 603-624.
15. Mahadevan, B., 2003. Making Sense of Emerging Market Structure in B2B E-Commerce. *California Management Review*, 46 (1), 86-100.
16. Brunn, P., Jensen, M., Skovgaard, J., 2002. e-Marketplaces: Crafting a Winning Strategy. *European Management Journal*, 20 (3), 286-298.
17. Kaplan, S., Sawhney, M., 2000. E-Hubs: The New B2B Marketplaces. *Harvard Business Review*, May/June, 97-103.
18. Morgan Stanley Dean Witter Internet Research, 2000. Collaborative Commerce. Downloaded from www.msdw.com/techresearch/index.html as at 27th August 2007.
19. Soh, C., Markus, M., 2002. B2B E-Marketplaces: Interconnection Effects, Strategic Positioning, and Performance. *System Information Management*, 1 (7), 77-103.
20. Christopher, M. 1992. *Logistics and Supply Chain Management: Strategies for Reducing Costs and Improving Services.* Pitman Publishing, London.

21. Poundarikapuram, S., Veeramani, D., 2004. Distributed Decision-Making in Supply Chains and Private E-Marketplaces. *Production and Operations Management Journal, Special Issue on Collaboration and Coordination in Supply Chain Management and E-Commerce*, 13 (1), 111-121.
22. Jutla, D., Bodorik, P., Wang, Y., 1999. Developing Internet e-Commerce Benchmarks. *Information Systems*, 24 (6), 475-93.
23. Cao, Q., Schniederjans, M. J., 2004. Empirical Study of the Relationship Between Operations Strategy and Information Systems Strategic Orientation in an E-Commerce Environment. *International Journal of Production Research*, 42 (15), 2915-2939.
24. Standing, C., Love, P. E. D., Stockdale, R., Gengatharen, D., 2006. Examining the Relationship Between Electronic Marketplace Strategy and Structure. *IEEE Transactions on Engineering Management*, 53 (2), 297-311.
25. Das, A., 2004. E-Provider Evaluation: An Exploratory Study. *International Journal of Technology Management*, 28 (1), 46-61.
26. Ferreira, D. G., Pinto Ferreira, J. J., 2004. Building an e-Marketplace on a Peer-to-Peer Infrastructure. *International Journal of Computer Integrated Manufacture*, 17 (3), 254-264.