Introduction

It is often claimed that information and communication technologies (ICT) will be for the economy what steam and machine power were to the industrial revolution. Riding this wave, e-business is coming to the forefront of international markets. Various new players have driven existing players to respond with their own Web sites and the development of electronic marketing channels. Such is the momentum for this revolution that Harvard Business School is experiencing a larger number of drop outs in its MBA program because of all the students launching Web companies, and US companies are experiencing difficulty in keeping their chief executives as they aspire to join “dot com” companies. Even though it sometimes looks like the sky is the limit to the (investment) opportunity in e-business, it sometimes looks as if we are e-mailing with Peterus@knocking on heaven’s door. While Shapiro and Varian (1999) explain that the old rules of economics still apply, because man (as an economic actor) has not fundamentally changed his behavior so far, what should be noted is that what is called e-business is still largely, in reality, e-commerce and sales and marketing driven only, rather than an integral business model.

Amazon, for example had to admit that it charges customers logistics costs which may off-set the price advantage to the customer. More importantly, it had to admit that frequently it does not know what the “true” logistics costs are. Perhaps, one might reason, this contributes to the continued losses the company is experiencing. Losses have increased in line with a growth in turnover last year, and it has been stated that the growth of the company lead to an increase in inventory, especially with product diversity increasing. This implies poor management of logistics and supply processes in this e-business.

Consider these findings from an Arthur Andersen survey of customers purchasing products on-line in the USA, fourth quarter of 1999 (Table 1). In the top ten problems experienced by end-consumers, some are in the category of technology[1], some are marketing related, but the top two factors are logistical factors, related to supply chain performance. Products not delivered on time or out of stock means receiving Christmas presents mid-February. Experts reflect upon
this by pointing out that the dot coms had underestimated the complexities of trading in volatile markets. Nor did they have the systems in place to report emerging stock shortfalls, manage vendors and complaints. Clearly, building a customer-facing Web environment is not all that difficult, but managing it with an underlying business model that includes an e-supply chain is something else. Experts (Andersen and others) suggest:

- Supply chain failures are compounded by a lack of rapid reporting structures to identify emerging stock shortfalls, order processing systems to manage the needed repeats, and vendor quality management programs to ensure minimal complaints and returns.
- These companies have dressed the shop window with slick Web sites, but there is no technology behind it to fulfill the order. Systems are already inadequate for big volumes, before adding new developments using mobile phones to access the Web. Companies are creating a demand they simply cannot fulfil.

Additionally, we are currently in the midst of what might be called the second wave of e-business. The first wave was that of the start up dot coms, some of which have already gone bankrupt – others are now more carefully monitored at the stockmarket, and hardly any have yet fully delivered on their promises. Thus, the second wave may become more important as it centers around existing companies with a heritage in the brick-and-mortar world who are now penetrating the e-business environment. Companies with existing and well-established processes and performance are now adding e-business to their portfolio and many are investing deeply. Their experience may help enhance performance of e-business concepts, but their heritage may also hinder drastic adjustments to their business model.

The second wave indicates how e-business is seen as a general and massive e-business opportunity in many sectors of the economy, and how expected revenues are high (judging upon the size of initial investments). The main argument, however, is that, in order to earn back investments and realize the promise of e-business, the creation of e-supply chains is needed, especially now that more experienced companies are becoming involved and investments in e-business are rising. The e-supply chain is the physical dimension of e-business with the role of achieving base level operational performance in the physical sphere (fulfillment, etc.). Additionally, it provides a backbone to help realize more advanced e-business applications that companies will obviously be unable to achieve if base level performance is not even up to market requirements, as indicated in Table I.

In order to introduce the relevance of e-business from a supply chain perspective, the next section will explain how e-business applications can support the realization of supply chain objectives. Supply chain approaches to e-business will then be developed. In these approaches the creation of an e-supply chain is considered of central importance. This is aimed at moving beyond

<table>
<thead>
<tr>
<th>Problem</th>
<th>Percentage of respondents</th>
<th>Type of mistake</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Gift wanted to purchase was out of stock</td>
<td>64</td>
<td>&gt; Logistics mal-performance</td>
</tr>
<tr>
<td>2. Product was not delivered in time</td>
<td>40</td>
<td>&gt; Logistics mal-performance</td>
</tr>
<tr>
<td>3. Paid too much for the delivery</td>
<td>38</td>
<td>&gt; Logistics and sales service</td>
</tr>
<tr>
<td>4. Connection or download problems</td>
<td>36</td>
<td>&gt; Technology mal-performance</td>
</tr>
<tr>
<td>5. Did not receive confirmation or status report on purchase</td>
<td>28</td>
<td>&gt; Logistics and sales service</td>
</tr>
<tr>
<td>6. Selections were limited</td>
<td>27</td>
<td>&gt; Marketing/assortment</td>
</tr>
<tr>
<td>7. Website too difficult to navigate</td>
<td>26</td>
<td>&gt; Technology mal-performance</td>
</tr>
<tr>
<td>8. Website did not provide information needed for purchase</td>
<td>25</td>
<td>&gt; Logistics and sales service</td>
</tr>
<tr>
<td>9. Prices were not competitive</td>
<td>22</td>
<td>&gt; Marketing/assortment</td>
</tr>
<tr>
<td>10. Website did not offer enough gift ideas</td>
<td>16</td>
<td>&gt; Marketing/assortment</td>
</tr>
</tbody>
</table>

Source: Arthur Andersen (2000)
the poor supply chain organizations underlying current e-business applications. In order to further support the realization of e-business objectives through the e-supply chain, relevant innovative practices are then developed. These are aimed at furthering the contribution of the e-supply chain, making it a backbone of revenue creation that can help earn back the amount of investment and effort currently going into e-business.

**The relevance of e-business to the supply chain**

Theoretically, there are multiple benefits from using information and electronic business concepts in the supply chain. Various authors have reflected on the specific potential of ICT for individual functional areas such as marketing (McKenna, 1997), purchasing (Ellinger and Daugherty, 1998) and logistics. In particular, ICT is expected to make the flow of goods transparent (Bowersox and Daugherty, 1995), allow for the integrated management of a physically des-integrated unit (LaLonde and Powers, 1993), and decentralization and centralization within one operating system (Bowersox et al., 1992). More specifically, Lee et al. (1997) point to the relevance of information exchange in avoiding one of the best known problems in the supply chain, that of Forrester's bullwhip effect.

The theory says that irregularities and unpredictability in order quantities increase with the number of layers in the chain. Because a supplier faces uncertainty about the order quantities of a direct customer, he will anticipate demand with inventory, speculative production, etc. Because the supplier of the supplier faces the same uncertainty in his relation with the supplier of the customer, the supplier's supplier will face considerable volatility and further anticipate orders, leading to even greater speculation at this point in the supply chain. Specifically, orders to suppliers tend to have larger variance than sales to the e-buyer and the distortion propagates upstream in an amplified form. This is a result of information transferred in the form of sequential orders (with tight time windows for delivery) being distorted and misleading upstream supply chain members in their production and inventory decisions. In addition to the upstream cumulative volatility in inventory, waste and possible chaotic behavior which result from the Forrester effect, the effect can be experienced not only upstream in the chain but also downstream, as displayed schematically by the volatility in the supply chain moving upstream and downstream from the original equipment manufacturer in Figure 1.

In traditional supply chain arrangements where the manufacturer or original equipment manufacturer (hereafter: OEM) is often the focal company, supply chain optimization may be driven by the considerations of that company, rather than from a supply chain optimization perspective, so creating Forrester effects up- and downstream throughout the chain. According to Lee et al. (1997) information and management can provide an important remedy for these effects. In the sphere of information and technology, visibility of demand throughout the supply chain and electronic linkages to create transparency of orders and operations are among the remedies studied.

If the information flow is such an important element of the supply chain, why do information-based companies such as Amazon achieve such poor supply chain performance? The answer probably has more to do with management solutions than technology. In that respect, the next section will introduce management approaches relevant to realizing the virtual supply chain.

**E-supply chain approaches**

The two basic problems with the Amazon supply chain, very much in line with the expert quotes in the introduction, are its partial, as opposed to integral, supply chain scope and its operational, as opposed to strategic, approach to information in the

*Figure 1 Traditional supply chains are suffering from poor information exchange*
supply chain. Its supply chain is integrated using information from the sales interface and partially to the logistics operations of its service providers, yet not throughout the entire supply chain. As a result, observers point at the lack of reporting structures to identify emerging stock shortfalls, order processing systems and the lack of technology behind the shop window, needed to actually fulfill demand. Moreover, the use of the information is operational in nature – it is used to organize shipments, order products, etc. More advanced strategic utilization of the information in the supply chain is not practiced.

Figure 2 illustrates the two primary dimensions that can be used in assessing the supply chain approach to e-business: the supply chain scope of e-business applications (which can be partial and limited to segments of the supply chain only or integral throughout the entire supply chain); and the approach of information to be used in the supply chain (which can be operational and ad hoc only, or more structured and with a greater impact, up to a strategic business enhancement approach). Whereas current practice, as indicated in the Amazon example, usually falls in the left bottom quadrant, the true e-supply chain needs to be in the upper right quadrant, as will be explained below.

First, there are many calls for connectivity and transparency in information flow as a qualifier for information integration (see Bowersox et al. (1992) and CLM, 1995) in which connectivity between supply chain layers and transparency of information as mentioned in the previous section are used as elements of world class logistics capabilities). However, this requires the establishment of a basic information infrastructure in the supply chain. Bar codes as an information source are one example of a possible infrastructure. Bar codes are often used in a warehouse, sometimes stretching as far as final delivery but for the support of operational systems only. An interesting development along these lines would be to apply the system throughout the supply chain. Exel/Reebok, for example, is beginning to attach bar codes in production and use them all the way through the supply chain until the point of sale (and back for obsolete products).

Thus, the information flow in the supply chain should not be used for operational/transactional purposes only, but for strategic advantage as well. Information integration by third-party logistics service providers, called fourth-party logistics (4PL) by Arthur Andersen and practiced by UPS Worldwide Logistics, leverages operational information for the strategic benefits of learning, supply chain engineering and competitive differentiation. The operational information about the transportation and distribution stages of the supply chain is recorded and can be used to monitor transportation links, identify opportunities for lowering costs by shifting volumes between routes or realizing a competitive advantage through differentiating

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**Figure 2** Supply chain approaches to e-business

<table>
<thead>
<tr>
<th>Strategic approach</th>
<th>Operational approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Partial/fragmented</td>
<td>Integral</td>
</tr>
</tbody>
</table>

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Supply chain scope
services in response to the market information stored in the databases. The 4PL concept centers around information integration of transportation and distribution only, and thus represents a partially integrated supply chain scope. Also the 4PL will compete with virtual transport markets or auctions where transport supply is accessible on-line for transport buyers to book capacity (Crowley, 1998).

Nike has developed a supply-chain-wide advanced notification system for its products in which retail orders are shared with suppliers; the European distribution center receives an advanced notification of shipments leaving suppliers; and retailers are then pre-advised of the scheduled delivery of goods which are in the pipeline. As a result, connectivity and transparency between individual players in the information flow are taken to an advanced level in which the entire supply chain web is seamlessly integrated. In a strategic drive to leverage the basic information infrastructure for competitive differentiation, Nike is now developing closed sites for its long-term preferred suppliers in an attempt to leverage transactional data and open databases relevant to order fulfillment. Suppliers will be able to learn about future initiatives and will be free to contribute to, or raise, additional supply chain improvement opportunities. As another example, UPS can make a bigger supply chain contribution by becoming involved in the online ordering of supplies on behalf of its clients, based upon inventory status information in its databases, ultimately leading to a more integral scope of its involvement in the supply chain and potentially leading to the creation of an e-supply chain (upper right quadrant of Figure 2).

The supply chain of the Smart car also represents an experiment in this sphere. On-line ordering on the Web, or the engineering of a customised car using multimedia tools in the showroom, is directly and electronically linked to production planning. The production plan is shared with suppliers who receive orders in real-time from the OEM, using the supply-chain-wide information infrastructure. As a result, the entire supply chain is involved in the concept. Additionally, information is not only used for operational ordering purposes but also as a strategic, long-term resource for competitiveness and further innovation in the supply chain. Customer information recorded in the showroom, for example, is also used for data-mining. Recorded customer preferences, customer characteristics and customer profiles are used as an input to the further development of product options, service elements and future generations of the product. In the supply chain a multitude of companies co-operate in a web-link environment (which is multi-directional rather than linear and sequential as in the traditional Forrester approach) and the information flow is a critical tool for the OEM to integrate and direct the supply chain. Note here that as a result the OEM is hardly present in the physical sphere anymore as it adds only about 10-15 per cent of operational added value (van Hoek, 1998).

The e-supply chain format resulting from these initiatives is different from traditional e-commerce and purchasing approaches in that:

- A supply chain-wide information infrastructure is used to directly disseminate relevant market information throughout the chain as a whole, avoiding a loss of time and “noises” leading to Forrester effects.
- The supply chain partners can co-operate more intensely around market opportunities and with broader and more elaborate co-ordination mechanisms,
- Information is not solely used for ordering and transactional purposes, but as a long-term resource for innovation, enhanced consumer relations and service propositions (such as: “Feel free to design your own car and have an impact on our innovation efforts too”).
- The fact that the e-supply chain approach runs through the various layers and players in the chain (as opposed to an internal virtual enterprise model) not only helps avoid costs resulting from Forrester effects. It also brings companies into a position to re-engineer the supply chain for competitive differentiation and improve focus on key competencies. The OEM in the Smart case, for example, focuses almost exclusively on supply chain co-ordination while leaving most of the operational activities to specialists.

Figure 3 displays the full framework for moving towards an e-supply chain as introduced here, including the above mentioned changes in organizing and
managing the supply chain, indicated using arrows.

**Relevant practices**

Having outlined the generic approach to establishing an e-supply chain, specific themes can be suggested where research and practice can make a valid contribution. Having mentioned that the e-supply chain is under-practiced, it should also be noted that a large effort is worthwhile in contributing to the realization of the concept. Judging by the amount of investments and research going into e-business this may well be achievable. Our rapidly growing library of over 150 papers and articles on e-business and supply chains suggests that this is likely to come into place, making these suggestion or research opportunities highly relevant. The assumption here is that e-supply chains will be created so that companies can pre-qualify for the following practical benefits.

It is worth looking at digital distribution and structures of e-supply chains. Despite the efforts of UPS to benefit from the e-business waves by offering services tuned to this business arena, an e-supply chain might not need physical distribution but use digital distribution instead. For example, texts and music can be distributed on-line for the client to download. Figure 4 lists some factors of concern in assessing whether or not to consider digital distribution.

In considering the role of digital distribution, the value/volume ratio of a product is the first factor that deserves attention. Especially products with a high value and a relatively low volume (for example computer memory chips) can “carry” more expensive express transport modes often used in e-commerce, whereas products of lower monetary value that are more voluminous (such as diapers) would benefit more from digital distribution if it avoids transportation costs. However, such products might be more difficult to digitize (the second factor of concern). Finally, there is a “feel” component to the purchase of some products. Customers buying a car will want to
see, drive and test the car before e-buying it or receiving a product digitally, which is why samples of CDs can be played on CD Web sites and why e-commerce channels are often a supplement to showrooms of traditional stores. It might be that regular purchases of standard products (a book is the same book wherever purchased) are best serviced with an electronic purchasing or commerce.

In further studying the role of e-supply chain structures the stages in virtual integration from Rayport and Sviokla (1995) are relevant. Practice is moving away from the first stage, in which the information flow is partially integrated. The flow of information has to be integrated with the flow of goods (in the second stage), followed by an approach focused on creating new products, services and markets based upon the synergy between the flow of information and goods. During these stages various options for structuring the supply chain are relevant (see Table II).

In the initial stage, when the flow of information is still fragmented, a McDrive concept might be used. In this approach the customer can order at a distance but has to pick up goods from a store or collection point (as practiced in grocery and book retailing). With that approach, the information flow does not have to be extended throughout the entire supply chain. An electronic order may simply generate a pick order in a warehouse or a shop near to the customer. The customer then performs part of the logistics function by collecting the product.

In the progressive second stage, digital distribution can be applied because the information flow is fully integrated, from source to customer. In the final stage, new markets and services can be created using the virtual supply chain possibilities such as central stocks (Central European warehouses for example) from which products can be rapidly shipped to the customer, in combination with product customization from the warehouse, based upon a Web-based product design developed on-line by the customer (as practiced by Barbie/Mattel for example).

Cost decreases and performance enhancements increase with the supply chain scope of e-business initiatives. In other words, the more integrated the effort and the more virtual the supply chain, the larger the potential benefits. This suggests that penetrating e-business should by no means be limited to establishing a customer facing an e-commerce business model only. The full supply chain should be integrated if the model is to function properly. The difficulty is, however, that the practical experience introduced here suggests that the further upstream and the more integrated the supply chain focus is, the more time-consuming and complex it is to achieve.

Conclusions

Expectations about the impact of information and communication technologies on business are high. This paper calls for more research into e-roles for supply chains, based upon the realization that the supply chain is often neglected in current e-business applications, and suggests the creation of an e-supply chain to help realize the promise of e-business. Fundamentally, if approaches to the flow of information in the supply chain remain operational and fragmented then strategic and supply-chain-wide benefits will not be realized. Specific opportunities, such as digital distribution, for furthering the contribution of the e-supply chain to enhancing competitiveness have been proposed. Hopefully research and practice can further develop, test and help operationalize them. Otherwise we may run into the situation were “everything” only starts with an “e”.

Note

1 Download problems are a key concern themselves because the competitor is a click away and the average consumer is willing to wait no more than seven seconds for a download – so much for customer loyalty!

Table II Further options for e-supply chain structures

<table>
<thead>
<tr>
<th>Stage</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Partial integration</td>
<td>McDrive concept (customer performing logistics function)</td>
</tr>
<tr>
<td>2 Full integration</td>
<td>Digital distribution</td>
</tr>
<tr>
<td>3 Cross-flow synergies</td>
<td>New structures around virtual supply chain e.g.: EDC (time and place), Web site management (form)</td>
</tr>
</tbody>
</table>
References


CLM (1995), *World Class Logistics*, CLM, Oak Brook, IL.


