[1]Ch 12

Electronic Integration of Supply Chain Operations: Context, Evolution and Practices

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Introduction

Successful companies seem to be, nowadays, those that have carefully linked their internal processes to external suppliers and customers in unique supply chains (Frohlich and Westbrook 2001, Boyer, Frohlich and Hult 2004). In this effort towards linking internal processes to external suppliers and customers, the sharing of information among enterprises is absolutely critical. Electronic data interchange (EDI) in the past and the internet in the last decade have enabled supply chain partners to act upon the same data (Christopher 2005). This reality explains much of companies' initial enthusiasm regarding the introduction of the internet and internet-based application in the early 1990s. Companies' ultimate goal of process integration across the entire supply chain was now much more feasible than ever before.

In the literature, the role and the potential impact of the internet on companies and on supply chain operations are not questioned and have received significant attention. However, in many cases the role of the internet in integrating supply chain operations has been approached in a quite generic way (Cross 2000, Croom 2000, Auramo, Kauremaa and Tanskanen 2005). Moreover, most of this research focuses on knowledge and information high-intensive sectors. In addition, much of the confusion regarding the internet's role in integrating supply chain operations derives from the fact that the notion of integration is not very clearly defined yet. The complex nature of supply chains and the different levels of operations integration that exist add significant difficulties and complexity to understanding the internet's true contribution. Consequently, the role and the contribution of

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internet in integrating supply chain operations is not fully explored and understood. As a result, in many cases companies' initial enthusiasm has been transformed into scepticism and in some cases even in negativism, as companies often find difficulties in quantifying or even clarifying the role and the benefits of the internet. This chapter intends to increase the understanding of electronic integration and its impact on supply chain operations. The objective is initially to propose an overall framework for supply chain integration, based on which the role of the internet is further examined in different business sectors, since most research focuses on a specific business sector, which often limits the applicability of the findings and the ability to generalize the results. Through secondary data research and literature review, the following research questions are going to be investigated:

- RQ1. What is the context of supply chain integration?
- RQ2. What is the contribution of the internet in integrating supply chain operations in different sectors?

In other words, the chapter will try to empower the understanding regarding the real value of the internet for companies and, particularly, whether or not and in what way this value appears in different sectors.

The context of supply chain integration

The concept of supply chain integration, although not a new one is still receiving significant attention in the literature (Harland et al. 2007, Van der Vaart and van Donk 2008). As many authors argue (Gunasekaran and Ngai 2004a, Pagell 2004) the integration of all activities that add value to customers, starting from product design to delivery, is the cornerstone of supply chain management, and the performance of a supply chain is dependent to a great extent on its level of integration (Stock, Greis and Kasarda 1998, van der Vaart and van Donk 2008). However, a survey by Bagchi and Skjoett-Larsen (2005), in more than 100 European firms, revealed that while performance seems to have improved as a result of collaboration with suppliers, and in some cases with customers, the nature and extent of integration has been a bit selective. Despite the importance of supply chain integration, the concept is not very well defined and difficult to measure empirically (Frohlich and Westbrook 2001). Much of the confusion is due to the fact that

researchers tend to pay attention to specific sectors or specific companies, which are performing much better than the majority of companies.

In this paper, the approach followed regarding supply chain integration is the one proposed by Matopoulos et al. (2007). Their framework consists of three dimensions:

- Direction of integration
- Width of integration and
- Levels of integration

The first dimension in this framework is the direction of integration. It refers to the multitude of the entities and their place in the supply chain, in relation to the focal company. Based on the categorization provided by Stevens (1989), and Fawcett and Magnan (2002), three type-levels of integration exist, namely backward, forward and complete integration. Backward integration involves integration with valued first-tier suppliers or even second-tier suppliers. Analogously, forward integration involves integration with valued first-tier customers or even second-tier customers. Finally, complete integration, includes forward and backward integration from the 'suppliers' supplier to the customers' customer'. Managers who are responsible should first examine the characteristics of their supply chain in terms of the type of product moved and the type of entities participating. Product or partner constraints may put significant limitations on the direction of integration.

The second dimension in the framework refers to the extent of operations involved in the integration (width of integration). Fawcett and Magnan (2002), suggest that one way of dealing with the diversity of definitions is to concentrate on some of the core processes and functions related to the management of supply chains. Drawing from the literature (Cooper, Lambert and Pagh 1997, Ross 1998, Mentzer *et al*. 2001) these key business processes include not only basic operations, such as procurement, inventory management, production planning, transportation, order processing and customer service but also marketing, promotion, sales, product design and new product development, processes that expand the organizational boundaries of individual companies. It is clear, that integration may not be applicable to all supply chain operations and, moreover, may not be applicable in the same way for different sectors. Therefore, managers who

are in charge should be in position to evaluate the strengths of each participant in their supply chain and to identify and prioritize integration opportunities based on the feasibility criterion.

The third dimension in the framework considers the level of integration based on one of the most widely accepted classifications of decision-taking levels: strategic, tactical and operational. At the strategic level it is important to identify what the long-range aspects of integration are, for example, if the competitive strategy of a firm has changed due to the integration of operations. The tactical level includes medium-term aspects. Finally, the operational level includes day-to-day decisions and actions. Managers should be able to identify what the appropriate level of commitment and involvement of each partner in the supply chain is. For example, companies that focus on the operational aspects of integration are less likely to invest in technologies that may alter their way of conducting business (new business models apart from the traditional).

Electronic integration

In this section the origin of electronic integration is presented and, furthermore, it is attempted to provide understanding regarding the evolution of the concept and the potential impact on supply chain integration.

Context and evolution

The concept of electronic integration has been approached in many different ways in the literature. According to Kambil and Short (1994), electronic integration refers to 'strategic choices made by firms to exploit EDI and Inter-Organizational System platforms to transform business processes and relationships, the business network or the firm's business scope'. Another approach, less strategic, is the one by Zaheer and Venkatraman (1994). They take a more process-based view of electronic integration, which is defined as 'the interconnection and integration of the business processes of two or more independent organizations through information technology applications'. In other words, electronic integration refers to a business model that combines the application of new technologies to the matching of supply and demand, collaborative partnering and/or outsourcing and coordinated logistics (Walters 2004, Power and Singh 2007). Electronic integration is by no means something new for companies. For more than 20 years, EDI application

was enabling companies to exchange information and data so as to bridge supply chain integration gaps. In particular, EDI enabled direct computer-to-computer transfer of information between independent organizations, providing numerous benefits such as reductions in data transmission error, clerical paperwork and inventory investment; and increased flexibility of response to rapidly changing customer demands and market environments (O'Callaghan, Kauffmann and Kosynski 1992, Peters 2000, Weber and Cantamneni 2002). Although the EDI approach achieved integration at the data level, it did not provide process integration. The development of the internet, particularly over the last decade, has provided an additional tool in an effort to deal with the incompatibility, the complexity and the increased development and installation costs of EDI (O'Callaghan, Kauffmann and Kosynski 1992, Peters 2000, Harrison and van Hoek 2008). Before the internet, achieving real-time demand information and inventory visibility was impossible and most supply and demand integration involved a patchwork of telephoning, faxing and EDI (Frohlich 2002).

Benefits and types of electronic integration

In the internet era, widely available web-based technologies now permit, more efficiently than ever before, strong customer and supplier integration for numerous intra-enterprise operations, such as inventory planning, demand forecasting, order scheduling, new product development and customer relationship management. The development of the internet has brought new ways of dealing with old supply chain problems. Its role in the evolution of supply chains has been already recognized in the literature (Gecowets and Bauer 2000, Lancioni et al. 2000). A significant body of literature has emphasized the benefits of electronic integration, often from different perspectives. Mukhopadhyay and Kekre (2002), for example, examined the strategic and operational benefits of electronic integration for industrial procurement. Sethi, Pant and Sethi (2003) emphasized the role of web-based integration on the new product development process. Grean and Shaw (2002) examined the impact of electronic integration on inventory and demand management. Benefits of electronic integration, however, are not always clear or direct and this is very much related to specific characteristics of the sector where it is applied. The research by Forster and Reagan (2001), for example, revealed that there was no direct impact of electronic integration in the US air-cargo industry.

According to Harrison and van Hoek (2008) supply chain partners can integrate electronically in three ways: transactional, information sharing and collaborative planning. Transactional integration refers to less complex and more operational business processes, such as purchase orders, invoices and advanced shipping notices. This type of electronic integration focuses on the automation aspect of these processes and the benefits are more relevant to the intra-organizational level. Information sharing is about transmitting and receiving information regarding pricing, promotional, inventory and shipment track and tracing issues. These processes are more at the tactical level than at the operational, and the benefits span the boundaries of the single firm. Finally, collaborative planning is the most sophisticated form of electronic integration, since it involves intense interaction and collaboration for long-term or even strategic processes such as new product development, joint demand forecasts, and replenishment planning. In this case, each piece of information needed by a supply chain participant is entered only once, through an automated process. Subsequent use and dissemination of that information is managed through software programs, without the need of manual intervention or translation. Communication of this information across geography, among facilities within a firm and between firms is accomplished seamlessly (White, O'Connor and Rowe 2004). The benefits at this level are not limited to the single firm, but are realized more in the supply chain as whole. In the following figure (Figure 12.1) the electronic integration ladder is presented, which is based on the overall research framework for supply chain integration suggested earlier and the types of electronic integration proposed by Harrison and van Hoek (2008).

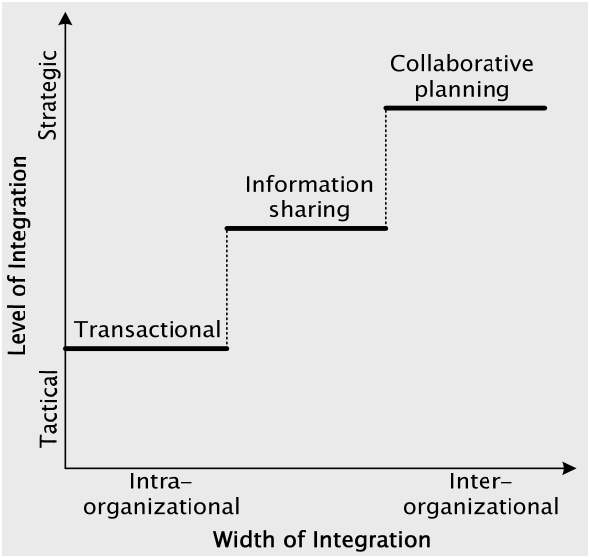

Figure 12.1 The electronic integration ladder

Electronic supply chain integration: Evidence from various sectors

In this part of the chapter, an identification of the role of the internet and its impact on supply chain integration is attempted in an industry-specific context. Based on the overall integration framework presented earlier and based also on the context of electronic integration, an exploration of the internet's contribution follows. The industry-specific context facilitates the identification of the real weaknesses and strengths of the internet in different sets of business environment and the type of integration that has been achieved. The business sectors that have been selected for exploration are: the automotive sector, the computer sector, the grocery sector and the apparel sector. The logic behind this selection was initially to include sectors with economic importance. Additionally, all four sectors are, to a great extent, global and represent both high- and low-intensive knowledge and information sectors. Finally, the availability of relevant data for those sectors was another important element.

Evidence from the automotive sector

The automotive supply chain consists of many different entities: numerous mainly small suppliers, a few, but very large, original equipment manufacturers (OEM's), numerous dealers and final consumers (Figure 12.2).

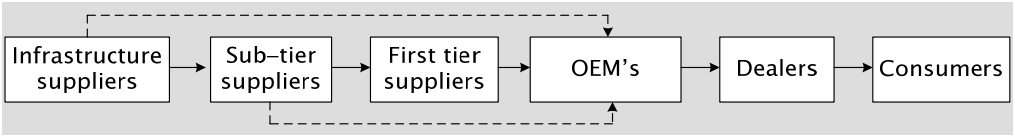

Figure 12.2 The basic automotive supply chain

During the last decade the automotive industry has been in the process of globalization in an effort to confront global over-capacity, rising stock levels and low profitability (Palm and Sihn 2005). Speed has also become a crucial issue in the development process, with manufacturers aiming to achieve significant reduction in the time-to-market cycle. In addition, most of the manufacturers faced the challenge of extending their production plans to different places than the traditional US—Japan–Europe triad (Lung 2000). These changes have resulted in an undisputed need for integrating supply chain operations beyond companies' boundaries, and the role of the internet in supporting this integration has been rather important.

In particular, regarding the direction of integration in the automotive industry, the internet has allowed for forward integration, with customers (for example dealers) getting more knowledge than even before regarding products and services they are considering purchasing (Handfield and Nichols 2002). Most automotive manufacturers have built powerful websites allowing customers to reach any of their products. Backward integration is more feasible in the automotive industry due to the use of the internet, which enables not only first-tier suppliers (as in the past with the use of EDI), but also second- and third-tier suppliers to have access on production schedules and plans (Handfield and Nichols 2002). Regarding the width of integration, the internet has extended the processes upon which suppliers and customers do collaborate. Over recent years, first-tier suppliers have risen in status, and their roles in the supply chain have been extended from the traditional activities related to material flow and sourcing to more complex activities, such as new product design (Palm and Sihn 2005, Neto and Pires 2005). Customers from this tier also not only can have access to prices, but, in some cases, become active parts in the manufacturing process by selecting colour, type of seat covers etc. For example, BMW allows customers to make changes to their vehicle, even within six days of final assembly (Gunasekaran and Ngai 2004b).

Even the level of integration in the automotive industry has been shifted from operational and tactical to strategic, with manufacturers communicating via the internet with executives from divisions all over the world, taking decisions on product development, market and pricing issues (Handfield and Nichols 2002). The clearest example in the automotive industry is the online marketplace, which was launched in 2000 by some of the major companies in the sector in their effort to manage their complex networks of suppliers, dealers, distributors and service providers (for example 3PLs). This global collaboration platform, with powerful dashboards and EDI interconnectivity, delivers information and applications, and facilitates processes such as collaborative forecasting and planning, order management, sales and service support and scheduling functions by linking each supply chain link. Potential benefits as a result of increased electronic integration include improvements of the delivery reliability for customers, reduction in delivery times for customer-specific vehicles and, of course, cost reductions (Wolff and Geiger 2000). Indeed, the survey by White et al. (2004), regarding communication methods in automotive firms revealed that automotive firms prefer EDI as the main communication method. EDI is followed by paper/fax and only a small number of communications is conducted with the use

XML/Internet. The survey also revealed that automotive firms were using the same methods with the same frequency whether they were communicating with suppliers or customers.

Evidence from the computer sector

The computer sector is a very complex one, requiring interaction and coordination among industry participants throughout the manufacturing process. Computers consist of thousands of discrete components, systems and accessories, which are designed and manufactured by numerous companies across the world. In the following figure (Figure 12.3) a representation of the computers supply chain is presented, along with the major product flows.

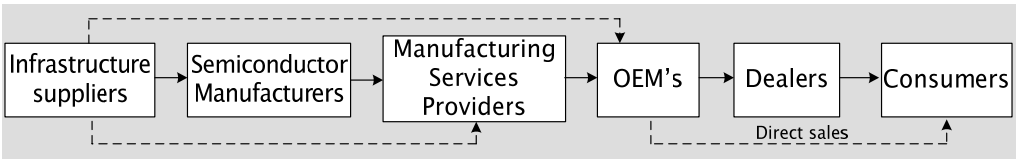

Figure 12.3 The basic computer supply chain

The computer industry is a very competitive one with powerful manufacturers competing on a global basis and being probably the most important players of the industry. Similar to the automotive industry, time pressures are also characteristic, perhaps even more crucial. Time-based competition has emerged as the winning strategy in the fast-cycle computer industry, where product life cycles are relatively short (two years or less) and computer products become obsolete in even less time than before (Rosas-Vega and Vokurka 2000). Apple, for example, was unable to fill orders for its new high-end line of G4 computers because of delays in the supply of chips, thus experiencing a devastating 14 per cent drop in revenue in 1999 (Gunasekaran and Ngai 2004b).

The main characteristic of the computer industry is the fact that most OEMs are using more or less the same components (for example, there are only two companies in the semiconductor business) and, thus, the competition game is mainly played on the basis of cost and customization, rather than on service and innovation, since OEMs can not realize unique value from common suppliers. As a result, OEMs continue a relentless pursuit of cost reductions and operational improvements, to drive supply chain efficiencies and to confront the continuing drop in retail prices and distributor margins. In their effort to achieve integration andimprovements, the internet has been quite important. In fact, the computer industry has moved much further along the path towards efficient

supply chain integration than the automotive sector, most notably through the efforts of industry-wide consortia like NEMI and RosettaNet (White, O'Connor and Rowe 2004). RosettaNet, for example, is a global consortium of major computer and consumer electronics, electronic components, semiconductor manufacturing, telecommunications and logistics companies working to create and implement industry-wide, open e-business process standards with the aim of aligning processes between supply chain partners on a global basis. The basis of the RosettaNet standard is Extensible Markup Language (XML). Despite the development of such a platform, much of the integration in the sector refers mainly to backward entities, although there are many cases of OEMs that have achieved forward integration, with Dell and Gateway being successful and well-known cases (Boyer, Frohlich and Hult 2004). In addition, regarding the width of integration, this is limited to less complex supply chain operations such as automating ordering and distribution.

Evidence from the grocery sector

The grocery industry is one of the most important industries and presents some interesting characteristics. Groceries are perhaps the most universal commodity; thus competition, along with varying customers' tastes and the perishable nature of products, often spurs retailers to go to great lengths to develop new technologies and methods of streamlining their supply chain efforts (Boyer and Hult 2005). Another characteristic of the sector is its diversity, since it is comprised of companies ranging from very small manufacturers to global retailers. In the following figure (Figure 12.4) a representation of the grocery supply chain is provided.

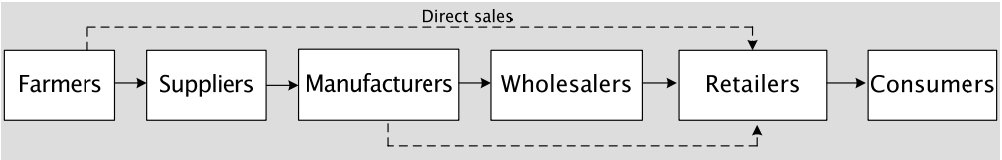

Figure 12.4 The basic grocery supply chain

A number of changes have occurred in the last decade in this sector. The entrance of global retailers, industry's consolidation, changing consumer consumption attitudes and the existence of stricter regulations and laws regarding food production as a result of the recent food crises (Hughes 1994, Kaufman 1999, Fearne, Hughes and Duffy 2001) have altered the business environment for most of the companies operating in the sector, encouraging a positive attitude towards integration and improvement. Despite the specific characteristics of the sector, it is one

where pioneering work for electronic integration has been conducted (Harrison and van Hoek 2008). Similar to the automotive and the computer sector companies, even competitors decided to invest on electronic integration. For example, in 2000 17 international retailers founded the Worldwide Retail Exchange (WWRE) to enable participating retailers and manufacturers to simplify, rationalize and automate supply chain processes, thereby eliminating inefficiencies in the supply chain. The WWRE is the premier internet-based business-to-business exchange in the retail e-marketplace, which enables retailers and manufacturers to substantially reduce costs across product development, e-procurement and supply chain processes.

The impact of the internet on supply chain integration has been very important, particularly integration between food manufacturers and retailers. Forward integration has been more intense at the retailer level, given the size of these companies, but not at the consumer level, which essentially remains at a distance and isolated from food production (Kaufman 1999, Fearne, Hughes and Duffy 2001, GMA 2000). Backward integration has been weak, as most of their suppliers are small to medium-sized companies, such as farmers, producer groups and cooperatives, which have not adopted internet-based applications (E-business Watch 2006). The width of integration has not been very extensive, with companies using the internet mainly for logistics activities, rather than for new product development and relevant activities (King 2001). This is also due to the fact that innovation and new product development is still conducted at the manufacturer level and has not been passed to its suppliers, which are usually growers and cooperatives. With regard to electronic integration, it seems, in most cases, to be limited to transactions, particularly at the supplier–food manufacturer level. However, some big manufacturers have established links with the retailers and have moved towards an increased level of electronic integration. For example, in many cases manufacturers are scheduling in the short- or mid-term, planning forecasts and promotion plans (for example, the use of the CPFR platform), in collaboration with the retailers. Sainsbury, one of the biggest UK retailers, developed a package that aims at reducing new product development time by up to a third of the traditional time by linking over its website a number of entities involved in the new product development process (e.g chefs, concept developers, manufacturers, nutritionists, marketers, design studios, artwork and reproductive houses, and product safety and legal experts). For example, a technologist on a supplier visit to South America can log on and approve packaging details online, keeping the

project on time (Sainsbury 2002). The system enables all parties to access the data (same versions) online as needed. For example, if an ingredient was changed by the chef, an e-mail would be sent to the packaging designer alerting them to alter the packaging, too, which results mistake reductions (Sainsbury, 2002).

Evidence from the apparel sector

The apparel sector is also a sector with various segments. The apparel supply chain (Figure 12.5) consists of many diverse entities, which results in complexity. The sector has witnessed many changes since the 1990s. A large segment of the sector started to compete on low cost and this resulted in many manufacturers sourcing and producing from abroad. The apparel sector is very competitive and time-sensitive due to the fact that product life cycles are shortening and product proliferation is accelerating, even in the most basic garments. These trends have created increasing demand uncertainty, which has changed radically the basis of competition in the textile—apparel–retail channel (Hammond and Kohler 2000).

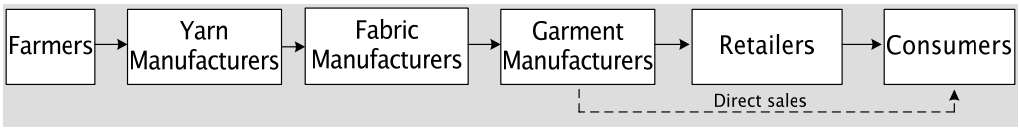

Figure 12.5 The basic apparel supply chain

In such a competitive sector integration was an absolute necessity, and was facilitated over the last 20 years by the use of EDI. However, due to the globalization of the sector, integration with the use of EDI was made difficult because of companies operating across borders with different languages, tax systems and document requirements (Mossinkoff 2006). In particular, regarding the direction and the width of integration, EDI at the beginning allowed mainly backward integration; however, this was restricted to less complex and more operational business processes, such as purchase orders, invoices and advanced shipping notices. Recent results from the survey of Teng and Jaramillo (2006), regarding the integration of the US textile and apparel supply chain with small companies in South America, reveal that it is difficult to achieve complete integration. This is mainly due to the inability of small supply chain partners to streamline their own internal processes. As a result, integration is limited to a few supply chain members and electronic integration focuses on the automation aspect of these processes; the benefits apply more to the intra-organizational

level. Information sharing is about transmitting and receiving information regarding pricing, promotional, inventory and shipment track and tracing issues. The problematic past EDI connectivity resulted in companies trying to invest on web-based platforms that would enable more integration, with more entities and more processes. Similar to other sectors and in an effort to overcome EDI inefficiencies, many marketplaces have been established since the early 2000s. These marketplaces were expected to enable and support linkages between retailer and apparel manufacturers, but also between apparel manufacturers and their suppliers, offering planning, procurement, product development and order fulfilment support. However, after the dot.com crisis, most of these marketplaces were abandoned. In most recent years, however, it is evident that big garment manufacturers are building powerful websites in an effort to achieve links directly with the final consumer. With regard to backward integration, they invest in EDI applications in order to achieve higher levels of integration in their already vertically integrated supply chain (Mossinkoff 2006).

Conclusions

This chapter has investigated the issue of supply chain and electronic integration. The literature revealed that the concept of supply chain integration is not well defined. For this reason, an overall framework was presented with the aim of contextualizing the concept in a more structured way, so as to provide a basis for analysis. The framework proposes three major dimensions: width, depth and direction of integration, which should be taken into account when trying to assess and indentify supply chain integration. The framework served as a basis to explore the role of the internet in supply chain operations in an industry-specific context. Assessing the real value of the internet on supply chain operations is particularly important since, in many cases, it may be overestimated as a result of internet 'euphoria'. Kanter (2004) very accurately argues that it is only now, as the unrealistic hype about the internet passes away, that the potential of the internet can emerge. Driven by this suggestion the chapter examined four business sectors with the aim of identifying the uptake of internet-based applications, as well as the impact that has been reported. The sectors selected were: automotive, computer, grocery and apparel. In some of the sectors explored, the contribution of the internet to the integration of supply chain operations proved to be more of a theoretical ideal than a business reality. This was particularly the case in the apparel industry, where companies, due to the specific characteristics of the sector and the way it is segmented,

have achieved supply chain integration, but this is rather limited to transactions. On the other hand, in the automotive, computer and grocery sectors there seems to be a more intense integration, particularly backward integration. In these sectors companies seem to have also achieved higher levels of electronic integration, but still they are far away from being truly integrated. For example, a comprehensive site-based study by Towill, Childerhouse and Disney (2000) of the European automotive sector found that only 10 per cent of supply chains could be regarded as fully integrated. A more recent survey by Poirier and Quinn (2003) similarly concluded that 10 per cent of supply chains in the USA had achieved external integration. In general, it seems that integration very often fails due to conflicting interests of the supply chain members, their specific characteristics and because of the lack of commonly accepted information technology and process standards (Nagy 2006). In fact, managers should bear mind that achieving supply chain integration involves many more things than just deploying electronic applications; the role of these applications should be supportive (Sanders 2005). This research has several constraints related to availability of data, which limits the ability to generalize the findings and conclusions. A more in-depth analysis of the sectors examined, as well as further analysis of other business sectors may be also needed. This will allow for generalizations to be drawn and more accurate and measurable assessment of the internet's contribution to supply chain integration.

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