

**EDI and Business-to-Business Systems:
The Status Quo and the Future of Business Relations in the
European Automotive Industry**

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Abstract

Electronic Data Interchange (EDI) has been used in businesses for over 40 years to reduce the costs of document processing. In this paper, we analyze the use of EDI in the European automotive industry depending on company-size and region. Even though EDI is strongly used by the European manufactures and suppliers, our empirical results show a clear trend that future Internet-based solutions for exchanging business documents and to support collaborative supply-chain business scenarios will significantly exceed the current level of EDI.

Keywords:

Electronic Data Interchange, automotive industry, inter-organizational cooperation, empirical data

Introduction

Electronic Data Interchange (EDI) has been used in businesses for over 40 years to reduce the costs of document processing and, in general, to achieve strategic business advantages made possible by shorter business process cycle times. Especially in the context of supply chain management, inter-organizational cooperations and the integration of heterogeneous partners' IT infrastructures have received broad practical and academic attention. The variety of different, often industry-specific, business process scenarios and EDI standards makes it difficult for businesses to decide on how to design corporate business processes transcending an enterprise's borders towards orchestrating entire supply chains. But traditional cooperation designs increasingly fail when confronted with globalized networks of partners and customers since they cannot incorporate the fundamental implications associated with network effects (Weitzel/Wendt/Westarp 2000). As part of a broader research framework incorporating practical and theoretical issues associated with networks as a competitive advantage, this paper discloses some important aspects of EDI usage in the European automotive industry and especially offers an insight into the particular business processes supported by EDI. In addition, the trend towards an even deeper future integration in terms of Internet-based automated collaborative business scenarios becomes clear.

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Research framework and related literature

Since multilateral process integration and thereby automation requires the orchestration of various interdependent economic agents, for example throughout entire supply chains, many approaches towards understanding the mechanisms behind interdependent systems like EDI networks draw from network effect theory (e.g. Farrell and Saloner 1985/1986; Katz and Shapiro 1985/1986; Yang 1997, Weitzel 2002). For a rich online bibliography see (Economides 2000; Agre 1998). Beneath theoretical deficiencies, among the biggest drawbacks of the literature on network effects is a lack of empirical data on business networks that can help explain frequently observed phenomena like user clusters and the diffusion of standards in networks. To address these drawbacks and to develop building blocks to a future interdisciplinary theory of networks, the research project "*IT Standards and Network Effects*" funded by the German National Science foundation that emerged from the interdisciplinary research program *Networks as a Competitive Advantage* analyzes these goals (<http://www.vernetzung.de/eng>):

- ▶ develop and evaluate coordination designs for agents deciding on ICT infrastructures
- ▶ explain diffusion patterns of technologies and standards
- ▶ gather empirical data from real life networks
- ▶ analyze cooperation strategies and technological approaches of standards consortia and e-business players in the IT sector
- ▶ congregate existing approaches, among others, from network effect theory, game theory, managerial accounting and controlling, and institution theory as a contribution to a general theory of networks.

The theoretical challenge is to extend the economic theory in order to capture network effects. The practical challenge is to come up with designs to reap some of the benefits associated with networks. An important part of this work rests on empirical research. Examining questions of managing IT standards in enterprises, we conducted an extensive survey from 1998-1999 with the 1.000 largest enterprises in the U.S. and Germany respectively ("Fortune 1.000") to gain empirical data about the corporate adoption and use of various IT standards like standard business software, office and communication software, and EDI. On the one hand, the study was designed to provide an insight into the determinants of strategic standardization issues like the diversity of software solutions, compatibility problems, and the centralization of decision structure. On the other hand, more detailed questions, e.g. about benefits and costs, were asked for the selected categories Internet and electronic commerce standards, business software and EDI. Full results are presented in (Westarp et al. 1999). For the benefits associated with traditional EDI (e.g. cost reductions induced by rationalization and automation, shorter order processing time) see (Emmelhainz 1993; Niggel 1994; Weitzel 2002. For earlier (mostly empirical) contributions to the literature on EDI see (Emmelhainz 1993; Deutsch 1994; Kilian et al. 1994; Niggel 1994; Picot et al. 1993; for WebEDI see (Curtis 1996; Densmore 1998; Waltner 1997)

Throughout the project, EDI networks proved to be among the most valuable sources for data on business networks because of both the economic importance of EDI and its associated relative sophistication in some industries as especially automotive: ever since the first EDI implementations in the middle of the 20th century (Parfett 1992 cites the LACES communication system at London's Heathrow airport as the pioneer application; Germany's MAN (internally) has used EDI since the early 1960s (Niggel 1994)) EDI standards have often tended to emerge from around individual major users and dispersed from there to become

industry standards. The automotive industry, characterized by large players and substantial revenues, has long been renowned for their role as a forerunner in EDI adoption. Extending and specializing our Fortune 1.000 study as the empirical foundation of our standardization framework, in late 2001 the Institute of Information Systems at the University of Frankfurt and the PA Consulting Group conducted a comprehensive empirical survey in the European automotive industry. Its design and most important findings are presented in the following sections.

Design of the study

In order to obtain data about the status-quo of e-business, research objects were standardized business software, EDI, supply-chain management, electronic markets and bilateral e-procurement. A questionnaire containing 45 questions on 9 pages (with two pages focusing solely on EDI) was sent to 800 suppliers and manufactures in the European automotive industry. Prior to mailing the questionnaire, each company was contacted by phone to identify the responsible managers to whom the questionnaire was then directly addressed. 125 relevant questionnaires from 9 countries were returned (15%) with the most respondents from Germany (48%), followed by Austria (16%), France (12.8%), Scandinavia (Norway and Sweden) (9.6%), Benelux (Netherlands and Belgium) (7.2%) and others (England and Switzerland) (6.4%).

In order to be able to identify possible dependencies according to firm size, with regard to their annual revenues we classified the responding enterprises as *small* (revenues < € 250 Mio.), *mid-sized* (revenues < €500 Mio.) and *large* (revenues > €500 Mio). On the whole, 48% of the 125 participants were small companies, 18.4% mid-sized and 33.6% large enterprises (Figure 1, left). To clarify the respective roles of the enterprises in the industry in more detail, we distinguished between manufactures (OEM, original equipment manufacturer) and different tiers, i.e. the level of a supplier in the supply chain in the view of an OEM (Figure 1, right).

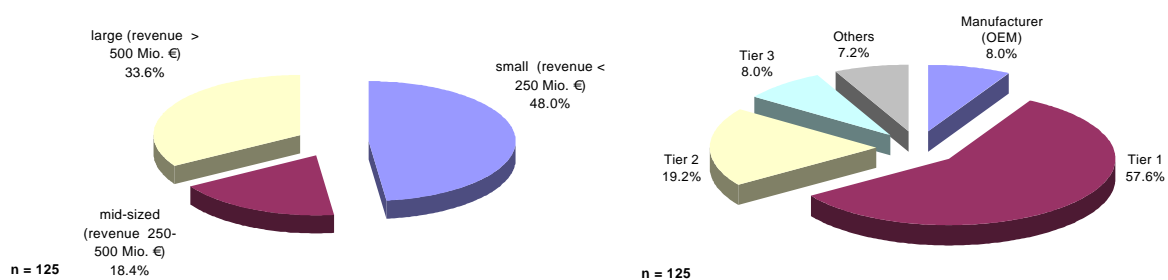


Figure 1: Size and supply-chain level of the responding enterprises

As shown in Figure 1 (right), the sample is dominated by 1st tier suppliers, followed by 2nd tier (19.2%), 3rd tier (8.0%) and OEM (8.0%). Further companies (7.2%) (e.g. logistics services provider) are summarized in the category others. For the survey's demographics see Figure 2 (left).

Results

General findings on EDI usage

First, we wanted to know if the respondents use EDI in their companies at all. Overall, 76.9% of all European suppliers and manufacturers use EDI. Looking at the different European

regions, Figure 2 (left) reveals that EDI is used in Germany and Austria the most ($\geq 80\%$) while French companies are on the last position (60%). In contrast, our previous Fortune 1.000 study showed that regardless of the particular industry only 52% of the biggest enterprises in Germany use EDI (while in the U.S. it is 75%). This supports the common hypothesis of the deeper average integration depth within the automotive industry.

Another typical finding is that larger enterprises are more likely to use EDI, partly due to the fact of course that here high transaction volumes make it more advantageous to economize on costs by process automation. Accordingly, EDI as a method for exchanging business data in the European automotive industry is most frequently used in enterprises that are large according to our definition given above (84.6%), followed by 77.3% of the mid-sized and 71.7% of the small enterprises (Figure 2, right). (For using of other methods for exchanging business documents (e.g. WebEDI / InternetEDI) see Fricke et al 2002).

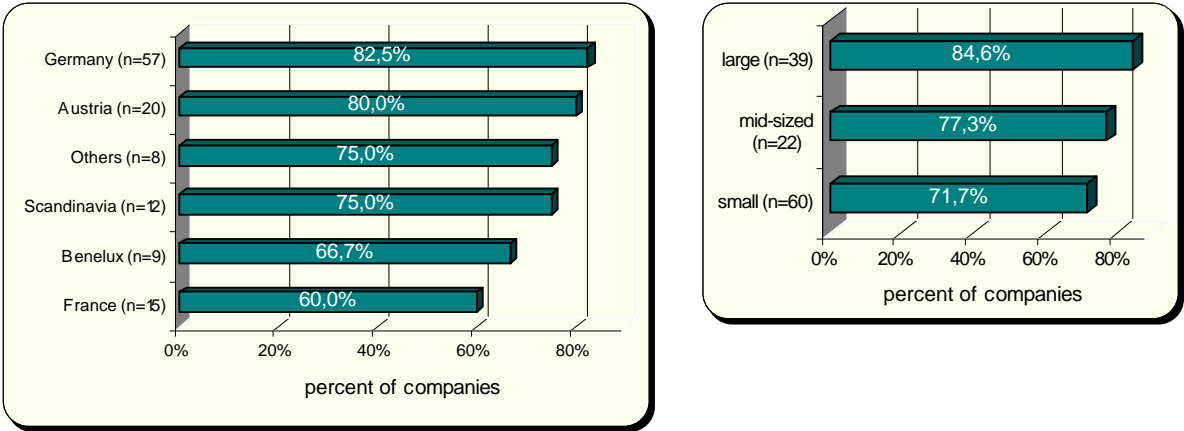


Figure 2: EDI usage in the automotive industry by region and enterprise-size

To analyze the use of EDI in the automotive companies in more detail, we wanted to know the fraction of all documents exchanged using EDI. It appears that on average 30% of all documents exchanged between the participating enterprises are EDI documents. This substantial use of EDI is quite extraordinary and emphasizes the often quoted leading role of the industry concerning integration in general and use of EDI in particular. Especially in the virulent question concerning the integration of very small enterprises in existing supply chains we mostly find only very small fractions of EDI documents, thus making an efficient automation of processes mostly impossible. In the German office supply industry with many enterprises' annual revenues below \$ 5 million, for example, we found that more than a third of the enterprises there use EDI in less than 10% of all cases even for such typical EDI processes like purchase orders (see below).

In German enterprises, EDI accounts for a considerable 37.8% of the total exchange of business documents. Even though on the whole EDI is used the least in French enterprises (see Figure 3), those enterprises that do employ EDI quite broadly use it for 29.4% of all business documents which puts France on the second position in this category. In contrast, the relative volume of EDI as part of all exchanged business documents is 24.1 % in Austria and 23.7% in Scandinavian enterprises (see Figure 3).

Despite the considerable percentage of EDI documents in the entire sample, once more size does matter: again we find the overall use of EDI within our sample increase with company

size. As shown in Figure 3 (right), 38.5% of all business documents in large companies are exchanged using EDI while this fraction is 26.9% in mid-sized and 26.0% in small companies.

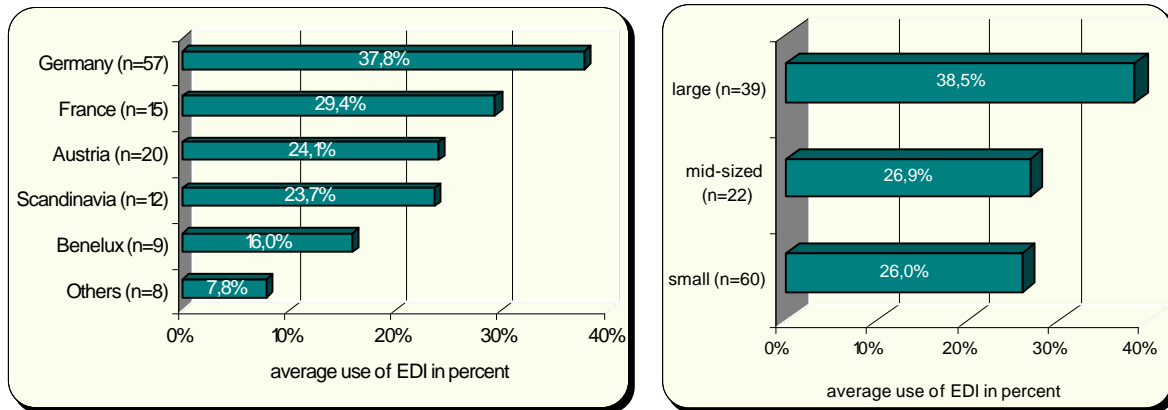


Figure 3: Fraction of EDI of all exchanged business documents by region and enterprise-size

EDI standards

We also wanted to know which EDI standards are used in the automotive industry. Figure 4 shows that VDA dominates our sample. 49.6% of all enterprises use VDA, followed by ODETTE (45.5%) and EDIFACT (14.9%). The remaining use their own propriety formats (9.1%), SAP-IDoc (2.5%) and other standards (5.0%).

A look at differences concerning the use of these standards in the different company-size categories shows that with 59% VDA is the most common EDI standard in large enterprises. 50% of all mid-sized companies and 43.3% of all small companies use VDA. In contrast to large and mid-sized companies, ODETTE is the most common standard in small enterprises (used by 46.7%). Enterprise-specific formats are used in large enterprises the most. As expected, SAP-IDoc formats can be found in large and mid-sized enterprises only. Figure 4 summarizes the findings concerning EDI standard and company-size.

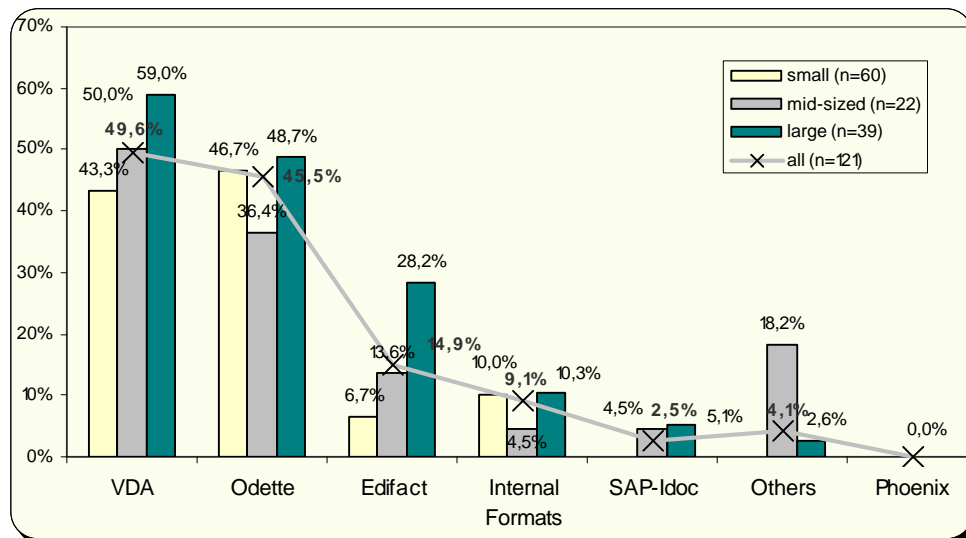


Figure 4: Relative number of enterprises using EDI standards

Looking deeper into those companies that employ standard business software (ERP systems), we find that 60.4% of the respondents use SAP R/3. This means, that hypothetically 60.4% of

the respondents could use the SAP-specific IDoc format to exchange business documents. About 35.2% of all small enterprises, 68.2% of all mid-sized, and 75.0% of the large enterprises use SAP R/3. For this reason, IDoc could have been the most common standard in large and mid-sized companies. Among the reasons why this is not the case are network topologies (not all direct supply-chain partners use R/3) and path dependencies (legacy systems etc.) and incompatibilities induced by different process execution scenarios and dissimilarly customized ERP and material management systems; additionally, there seem to be more converting tools available for EDI standards. Also, a significant correlation between the number of standards used in a company and the size of a company was found.

EDI document types

An interesting question that is surprisingly rarely analyzed is: what are the document types that are actually exchanged between business partners utilizing EDI? With 60.8% delivery schedules dominate the exchange of documents in our sample. 52.0% of the enterprises exchange orders, 58.8% purchase orders, 46.4% detailed schedules, 37.6% advanced shipping notifications and only 25.6% carrier specific shipping notifications (see Figure 5).

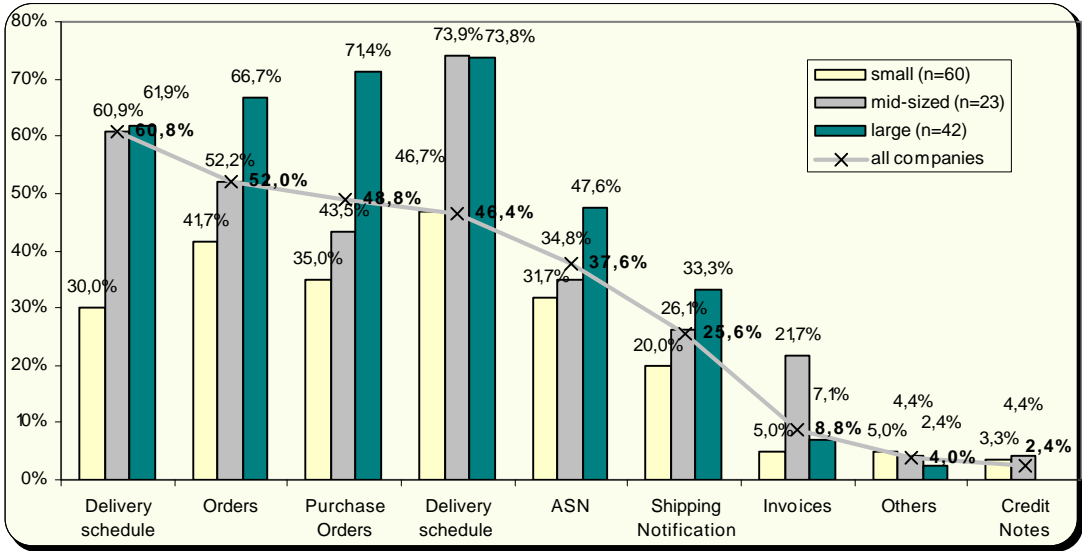


Figure 5: Type of business document exchanged by companies depending on company size (only EDI users).

Delivery schedules (forecast about goods required e.g. in a production plant), detailed schedules (detailed data including the exact delivery time etc. when goods are required) and advanced shipping notifications (information that goods are sent from an entity) are an integral part of just-in-time concepts. Looking at the different company-sizes it is obvious that delivery schedules are used by the automotive companies the most. 73.8 % of all large enterprises, about 73.9% of all mid-sized and 46.4% of all small enterprises exchange delivery schedules with their supply-chain partners. The results show, with an exception of small companies, a high use of just-in-time-based concepts. The less frequent exchange of carrier specific shipping notifications illustrates that the exchange of documents with service agents and logistics services provider is less distinctive (see Figure 5). While the exchange of purchase orders is very common in large enterprises, surprisingly invoices only seem to play a minor role.

Collaboration scenarios

The automotive industry is one of the largest industrial sectors world-wide. Through the internationalization of markets, manufactures and suppliers are increasingly forced to intensify their business relations in order not to lose competitive advantages. Therefore a higher level of integration, or cooperation respectively, is needed (Oliver and Webber 1982). Supply-chain integration implies more than just the simple exchange of business documents as mainly focused on in the previous section. The planning, execution and control of supply-chain activities requires an efficient use of information and communication technologies as well as the organizational willingness to cooperate (Swaminathan et al. 1998). This involves the sharing of information and knowledge that used to be considered proprietary or even strategic. Even further, supply-chain partners can make a joint decision based on combined information and knowledge (Lee 1998). Examples can be found especially in the area of *planning*. Manufactures and suppliers are increasingly involving their business partners into strategic as well as operative planning scenarios to find the optimal solution for all supply-chain entities involved. In contrast to the simple exchange of plan data, these scenarios are determined by a direct interaction between two or more entities and a synchronization of various restrictions and respective data sets.

Application domains are the inter-organizational or collaborative production planning (planning and optimization of production while simultaneously taking into account product and resource availability of different entities), demand planning (considering different causal factors that affect demand), inventory planning and deployment (business partners decide together e.g. in which locations of a distribution network goods should be stored) and transportation planning (service agent are involved in the planning of deliveries).

Beside the implementation of an inter-organizational tracking and tracing of status information (not limited to a company and its logistics service partners) available-to-promise services (Mertens and Zeier 1999) can be realized across the network. Using complex IT infrastructures across the entities, it is possible to identify the required goods according to the logistics principles.

In both, the literature and practical applications, the concept of information hubs is broadly discussed, where relevant data is consolidated in a central database that is accessible by various supply-chain entities. A consolidation of data across the supply chain can also be used to measure the performance of business partners, e.g. according to score key performance indicators (see <http://www.supply-chain.org/>) and thus the performance of the whole logistics system. A collaborative interaction can also be found in the area of development. Using centralized document management systems and data pools, enterprises involve their partner in engineering and design processes of complex products.

Beside the scenarios illustrated below, an intensification of business relationships can lead to a shift in tasks. Predominant examples are methods of continuous replenishment (e.g. vendor managed inventory (VMI) and buyer managed inventory (BMI)). For example, one way of mitigating the bullwhip effect is for partners to delegate the inventory decision either to the Vendor Managed Inventory or to the Buyer Managed Inventory (Lee, Padmanabhan and Whang, 1997). In VMI, products are automatically replenished by a supplier when stocks run low, and goods aren't sent unless they are needed, consequently lowering inventory at the distribution center or retail store. In contrast, in BMI the buyer has control of order quantities and timing.

Frequently these concepts fail in corporate reality because supply-chain entities are not prepared to externalize internal data or to turn over the optimal plan for a central perspective because of fearing adverse effects concerning their individual competitive environment

(Weitzel and König 2001). Hence, we wanted to know which cooperative business scenarios are actually executed in the automotive companies.

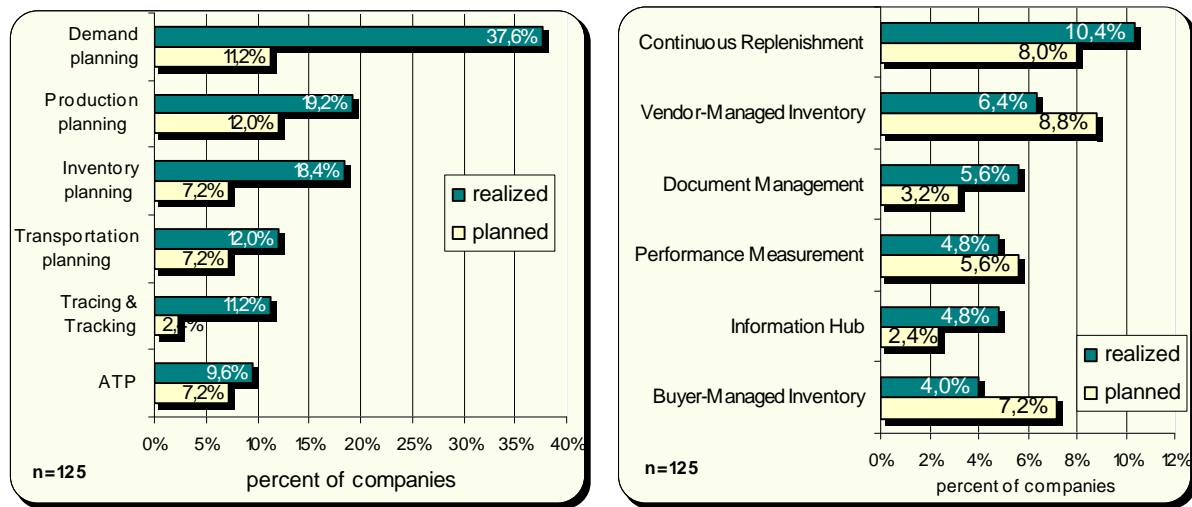


Figure 6: Collaborative scenarios by the automotive companies (realized and planned)

As illustrated in Figure 6 (left), demand planning (37.6%) is the most popular inter-organizational collaborative scenario in the automotive industry, followed by production planning (19.2%), inventory planning (18.4%) and transportation planning (12.0%). Surprisingly, performance measurement (5.2%), collaborative development (3.2%) and information hubs play a very unimportant role too.

As shown in Figure 6, the most interesting areas in the future are production planning, demand planning and continuous replenishment. 12% of all responding companies plan a deeper interaction with their business partners in the area of production, 8.0% in continuous replenishment and another 11.2% in demand planning. The realized and planned scenarios by the automotive companies show that beside the impressive exchange of documents, collaborative scenarios are less common.

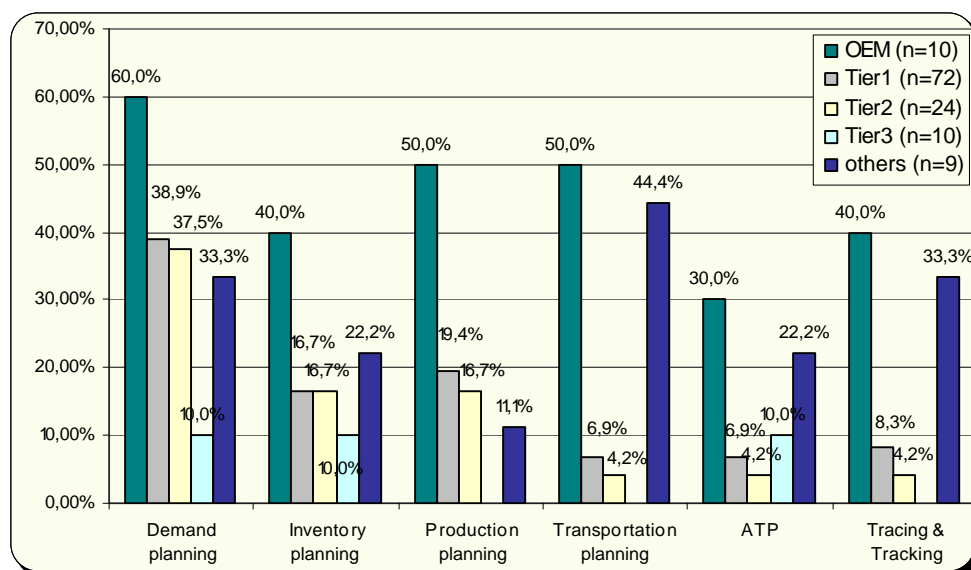


Figure 7: Realized collaborative business scenarios by supply-chain level

The supply-chain level perspective shows (see Figure 7) that OEMs dominate almost all collaborative business scenarios. 60.0% of the European manufactures comprise their business partners in demand planning, about 50.0% in production and transportation planning, 40.0% in inventory planning, inter-organizational tracing and tracking scenarios (see Figure 7) and collaborative development (document management). 30.0% of the European OEMs have realized ATP-scenarios and vendor-managed inventory with their partners. While continuous replenishment, buyer-managed inventory, and performance management are used by 20.0% of the responding OEMs, information hub is the most unimportant scenario (see Figure 8).

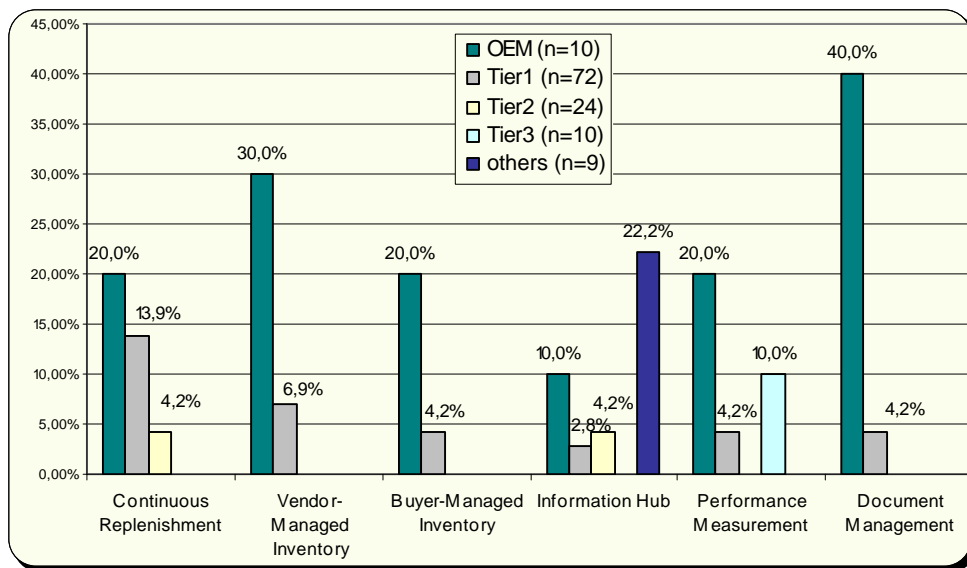


Figure 8: Realized collaborative business scenarios by supply-chain level

It is obvious that the realization of inter-organizational business scenarios decreases from the manufacturer to the supplier. As illustrated in Figure 7 and Figure 8, 3rd tier suppliers are rarely involved in complex business scenarios. The results also show that the companies summarized in the category “others” are involved in transportation planning, tracing and tracking and information hub the most. This can be explained by the number of logistics service providers assigned to the category (see Fricke et al. 2002).

EDI and Internet-based collaboration

To estimate the future of traditional EDI, we finally wanted to know if the automotive companies plan the illustrated scenarios using Internet's boundless architecture, permitting the free flow of information and ideas in real time among OEMs, suppliers, and dealers. We distinguished between bilateral internet connections (point-to-point) and the use of electronic markets.

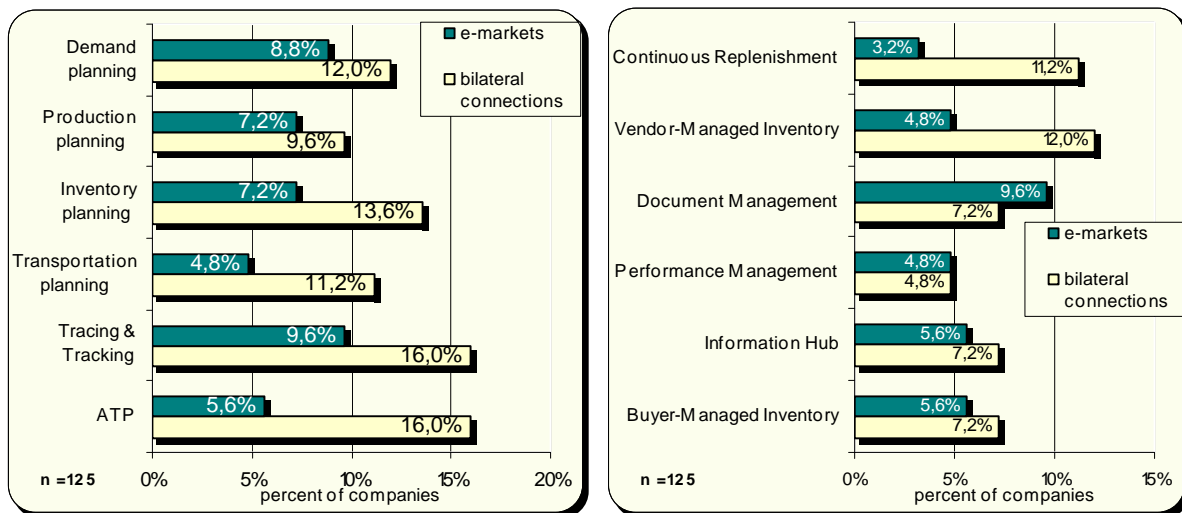


Figure 9. Planned bilateral Internet-based and e-market-based scenarios by the automotive companies

Looking at the results in Figure 9 and Figure 7 it is obvious that the importance of Internet-based scenarios has exceeded the rank of traditional EDI. Except the area of production planning all other scenarios in the field of bilateral Internet-based connections between suppliers and manufactures are more common than for traditional EDI. As a result, this can be interpreted as traditional bilateral EDI-methods being more and more substituted by Internet-based methods in the future. Further, buyer managed inventory, information hubs, the management of documents related to collaborative development, availability checks, status information tracking and demand planning have increased in importance in contrast to traditional EDI scenarios.

Conclusion

Examining the use of EDI and business-to-business collaboration scenarios in the European automotive industry showed frequency and type of EDI usage according to country and company size. Among others, between 60% and 82.5% (depending on size) of all respondents use some form of EDI for up to a third of all exchanged business documents, and there are huge differences in exchanged document types: while purchase orders and especially delivery schedules are quite frequent (up to 73.8% of the respondents), invoices are very rarely exchanged using EDI (less than 10%). Almost always, the renowned positive correlation between company size and EDI usage was obvious.

Looking deeper into different more sophisticated business integration concepts, the relation between realized and planned collaboration scenarios shows a clear trend towards an increased use of Internet-based bi- and multilateral integration despite the already exceptional integration depth in the automotive industry. From a practitioner's perspective the results are a clear indication for enterprises to keep focusing on building efficient networks with their direct and indirect partners in order to keep a sustainable competitive position. The theoretical challenge is to come up with coordination designs that enable a collective reaping of networks effects. Since building networks is both, a technological as well as an organizational matter, a prospective theory of networks as a competitive advantage has to incorporate both perspective.

Among others, empirical data as presented in this paper, has proven to be a valuable source of understanding some determinants behind communication networks.

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