INTERNET-BASED TOOLS FOR OPERATIONS MANAGEMENT:

RESULTS FROM AN ITALIAN SURVEY

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ABSTRACT

ICT-based innovation has a primary role in supply chain management, enabling improvements in physical, informative and financial flows management.
This paper presents some results of the research "Internet and supply chain management: new organisational and managerial models" based on a survey on 1458 firms operating in Italy and having more than 50 million euros turnover. 463 firms have taken part in the research, with a 31,8% response rate.
Results show a still scarce diffusion of internet-based tools in almost all the processes of supply chain management but order cycle activities. As to achieved performances, firms implementing such tools are mainly interested in cost reduction, but processes transparency and better information sharing are also sought for.

INTRODUCTION

Technological innovation is usually associated with performance improvement in terms of products, processes or business meanings. The main objectives of innovation are to satisfy customers needs and to manage supply chain operations as efficiently as possible. Information technologies, and the Internet in particular, have a fundamental role in supply chain management (SCM): in fact, they reduce distances and multiply communication, bringing up for discussion on governance models, players roles and intermediation forms.
Web-based technologies have been supporting and conditioning firm management with regard to offered capabilities and technical limitations; in this way the Internet can influence strategic and operational management, leading to new business models for the whole value chain. Firms have to survive in dynamic, international and aggressive markets, where new managerial competences are requested: increasing market turbulence and competition - in terms of quality, cost and service level - products life-cycle reduction, increased product and service variety and technology evolution are leading companies to search for higher flexibility, in terms of both mix, volume, products and technologies. Because of the difficulty to preside and manage many different technologies and competencies, the evolving scenario is shifting companies objectives.
Processes become more transparent thanks to the possibility of acquiring and sharing information in an easy and fast way (Deeter-Schmeltz and Norman-Kennedy, 2002; Ronchi, 2003). In the same way, better coordination among players implies - from a network point of view - mistakes and time reductions and contributes to stocks reductions (Akkermans et al., 2001). In fact, with regards to supply chain performance, scientific contributions (Frohlich, 2002; Frohlich and Westbrook, 2002; Ronchi, 2003) underline well-known logistic improvements in terms of information transfer speed increase, delivery flexibility and reliability growth and time and transaction costs reduction. These authors suggest some improvements in stock management, quality management and new product development process as well.

However, it is still unclear, for both firms and scholars, how Internet adoption models can influence the effectiveness of the technological solution itself.
The paper focuses on the diffusion of internet-based tools in supply chain management processes and related results in terms of performance improvements[1].
With respect to this objective, three issues are analyzed:

1. supply chain processes, with a particular focus on operations;
2. internet-based tools, as to both supply chain integration and e-procurement;
3. logistics performances improvements related to the use of such tools.

In the next section literature review is reported. Then, methodological issues are pointed out. Main results and conclusions will follow.

LITERATURE REVIEW

Supply Chain Processes

A number of researchers (Frohlich and Westbrook, 2002; Sanders and Premus, 2002) recognized the Internet as a powerful tool to improve business efficiency and effectiveness. Even more striking could be its strategic effects, in terms of value creation capability and customer needs understanding. New business models, such as demand satisfaction communities, can be enhanced by the Internet, resulting in deep changes in supply chain management (Hewitt, 2000). Even the final customer can play an active role in supply chain processes, co-creating unique value for him/herself (Poirier and Bauer, 2001; Prahlad and Venkatram Ramaswamy, 2004) thanks to the non-hierarchical and non-sequential nature of internet-based technologies.
Nevertheless, the mere usage of the Internet, without a deep re-thinking of supply chain structures, will hardly result in the complete development of its potentiality (Chandrashekar and Schary, 1999; Croom, 2001). Further, internet-based systems can be used to enhance both market and integration mechanisms (Garcìa-Dastugue and Lambert, 2003), and identifying the most suitable tool is a strategic decision, that should be coherent with company business strategies (Davila et al., 2003).
In fact, the Internet impact concerns not only operation management but it can also enhance new business models development, offering innovation opportunities and competitive advantage challenges (Wouters et al., 1999).
The main idea is that the Internet can support strategic activities such as integrated forecast, joined production planning, new product development, customer relationship management as well as operations like order cycle, stock and transportation management.
Some authors (Sarkar et al., 1993; Coltman et al., 2001) analyze web technologies influence on supply chain structure in terms of the number and the typology of players. Presutti (2003) proposes a suppliers base extension linked with e-procurement due to transaction costs reduction; on the contrary, Croom (2001) and Davila et al. (2003) suggest a supplier base rationalization. According to Christiaanse and Kumar (2000) the use of technology has to be associated with supply chain reengineering, removing some roles and changing the number of players. At the same time, new intermediation forms (Nissen, 2000; Amit and Zott, 2001) can growth up modifying the structure of supply chains.
In this paper we focus on the Internet impact on supply chain processes and activities. In this section scientific contributions are analyzed to merge existent knowledge on this topic with new inputs from our results.

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1 This study is part of a wider research, investigating the real chances the Internet gives in terms of new organisational and managerial models. The study, financed by the Italian Ministry for University and Research with FIRB - basis research funds - involved the largest Italian firms and is meant to map a scenario of the diffusion degree of internet-based tools for supply chain management and the related effects in terms of supply chain processes, structure, governance and performances.

Scientific studies suggest a number of taxonomies about adopted tools and supported processes, using different classification criteria. Process type is the most recurrent method to classify internet-based tools: ECR Italia (2001) introduces a distinction between e-procurement, e-supply chain, CPFR ed e-demand; Lancioni et al. (2000; 2003) and Rahman (2003) analyze the Internet adoption level in purchasing, inventory management, transportation, order processing, customer service, vendor relations and production scheduling processes.
Some authors (Frohlich, 2002; Frohlich and Westbrook, 2002; Muffatto and Payaro, 2003; 2004) separate upward and downward processes distinguishing supply and demand integration, or e-procurement and e-fulfilment. Eng (2004) distinguishes transaction-based services - such as catalogues and auctions - vs. strategic supply chain services, oriented to information and knowledge sharing after a long period perspective.
Using a very similar approach, the Politecnico di Milano (2003) introduces a distinction between:

- e-procurement processes, referring to suppliers scouting and catalogue or auctions sourcing and usually connected to spot and frequent purchases of non-core products.
- e-supply chain processes, referring to collaborative supply chain activities such as order fulfilment, conjoint planning and product development or marketing activities.

It is clear that different applications mean different managerial approach: e-procurement activities are performed when firm priority is time and cost reduction in supplier research, especially if they operate in an almost-perfect market, where price is the discriminating issue. On the contrary, e-supply chain processes concern integration and cooperation among players, with a particular focus on data standardization and system interoperability.
In this paper we assert that specific internet-based tools are chosen for strategic reasons and, thus, after the Politecnico di Milano taxonomy, we focus on 21 operations activities concerning supply chain execution, monitoring and control and collaborative planning (Table 1).

supply chain processes	**supply chain activities**
pre-sales	data alignment product visibility
order cycle	order emission order confirmation order change order progress complex products configuration
logistics	production planning receiving, stocking & handling management transportation planning delivery tracking delivery note management transportation document management
billing cycle	billing bill reconciliation bill tracking
after-sales	accounting information claim and warranties management
supply chain monitoring and control	reporting alert management quality management
collaborative supply chain planning	VMI, CPFR, continuous replenishment event management

Table 1 - operation processes and activities (our elaboration from Politecnico di Milano, 2003)

Internet-based Tools

When analyzing scientific contributions on the use of internet-based tools in supply chain management it is often difficult to separate taxonomies concerning supply chain processes from those regarding the adopted tools. Such difficulty is due to the fundamental overlapping of the different processes with the tools used to support such processes.
For instance, the above-mentioned taxonomy of Politecnico di Milano (2003) can be used to distinguish e-supply chain and e-procurement in terms of both processes and tools.
Other studies present the same feature: Cagliano *et al*. (2003) characterize e-commerce tools for forward relationships, e-procurement systems for upward processes and e-operations tools for value chain providing. Sanders and Premus (2002) point out operations-oriented tools, such as ERP e CPFR, and marketing-oriented ones such as catalogues and electronic auctions. Referring to coordination mechanisms utilized, Garcìa-Dastugue and Lambert (2003) identify two macro-classes: market and coordination flows. The first includes auctions, electronic agents and purchasing groups. Relationships management tools for information and knowledge sharing, such as web-EDI, belong to the second class.
Apart from the different approaches, a general trend is to classify internet-based tools into two macro-areas:

- coordination tools, supporting integrated order cycle and supply chain planning and control;
- e-procurement tools, supporting suppliers scouting and selection in spot transactions.

Consistently with the activities selected as unit of analysis, in this work we will focus only on the former. Thus, internet-based EDI, automatic data-exchange tools such as XML-based systems and web services and Extranets - both stand alone and integrated with internal management systems - are considered.

Internet-driven Logistics Performances

With regards to the effects of the Internet on supply chain management, different studies (Frohlich and Westbrook, 2002; Ronchi, 2003) point out operational improvements, but it is important to underline strategic effects such as collaborative data transfer, partnerships for new product development, customer satisfaction and loyalty increase. According to Eng (2004) perceived contributions of e-marketplace to supply chain management have to be examined in three dimensions: unit cost reduction, increased efficiency and streamlined operations. In particular, he identifies two types of benefits:

1. perceived benefits of transaction-based supply chain services - such as lower unit cost of procurement, dynamic and global sourcing and reduced time between billing and payment;
2. perceived benefits from strategic supply chain benefits - such as improved internal and external communication, efficient product introduction, streamlined electronic process and increased customer satisfaction.

Muffatto e Payaro (2004) analyze the global impact of the Internet on firm performances: they identify benefits in terms of data transfer errors reduction, better understanding of market trends, higher process visibility and better coordination with suppliers, overstock reduction. Customer orientation has to be considered a performance parameter: in fact, Bowersox et al. (2000), suggest relevancy for customer as a new driver of value creation.
In this paper we are interested in understanding which are the priorities of firms implementing internet-based tools, in terms of expected results. With this aim, beside logistics performances - such as delivery improvement and stock reduction - other effects, such as process transparency and customization enhancement, are considered.

METHODOLOGY

This study investigates the Internet impact on supply chain operations and governance: in particular the main purpose is to individuate new business models in terms of new supply chain configurations. For this reason, the analysis involves only large companies - more than 50 million euros turnover -because we chose to consider the most conductive firms of the supply chains.
The sample of this study was drawn from the MEDIOBANCA database published by the Italian Chamber of Commerce in 2004 and reporting balance data for 2003 and consists of 1458 companies.
As to the firm referent, it was decided to directly involve first-level managers from the functional areas of interest: first of all Supply Chain or Logistics and, as a second choice, Distribution, Procurement or Information Systems.
Data gathering was performed from May to October 2005 trough a first introductive contact and two following reminders: firm referents were contacted by phone then sent the questionnaire via e-mail and ordinary mail.
Two firms closed their activities during 2004 and were removed from the database: the final response rate is 32%, with 463 firms answering.
The questionnaire for the survey was designed in five sections:

- section A investigates supply chain features, in terms of outsourcing trends, partnerships, kind and number of suppliers and customers;
- section B analyses internet-based tools diffusion in supply chain management processes;
- section C describes the main effects of internet-based tools in terms of efficacy, effectiveness and customer value;
- section D gives a description of a selected supply chain relationship - with respect to governance, mutual dependence, embeddeness, bargaining power, information sharing;
- section E asks for general information about the firm.

The questionnaire considers about 230 variables and is twelve pages in length. Questions are in a four-point nominal scale - “not at all”, “a little”, “rather” and “to a great extent”: the even scale was chosen in order to avoid answers crowding the central value.
Some context variables - industry, turnover and number of employees - were also collected through MEDIOBANCA. The same source was used to collect balance ratios, in order to have a measure of firms performances.
This paper focuses on sections B and C, analysing the diffusion of internet-based tools in supply chain processes and related effects in terms of performance improvements.

RESULTS AND DISCUSSION

Responding firms are quite representative of Italian large firms as a whole, as to both the high response rate (463 firms out of 1458, about one third of the population), and the qualitative similarity between the sample and the population as to geographic area, firm dimension and financial ratios (see Figure 1 for geographic area and firm dimension). Nevertheless, as to the industry, most responsive firms belong to manufacturing rather than service industries, due to the scarce knowledge of supply chain related concepts of the latter (Table 2).

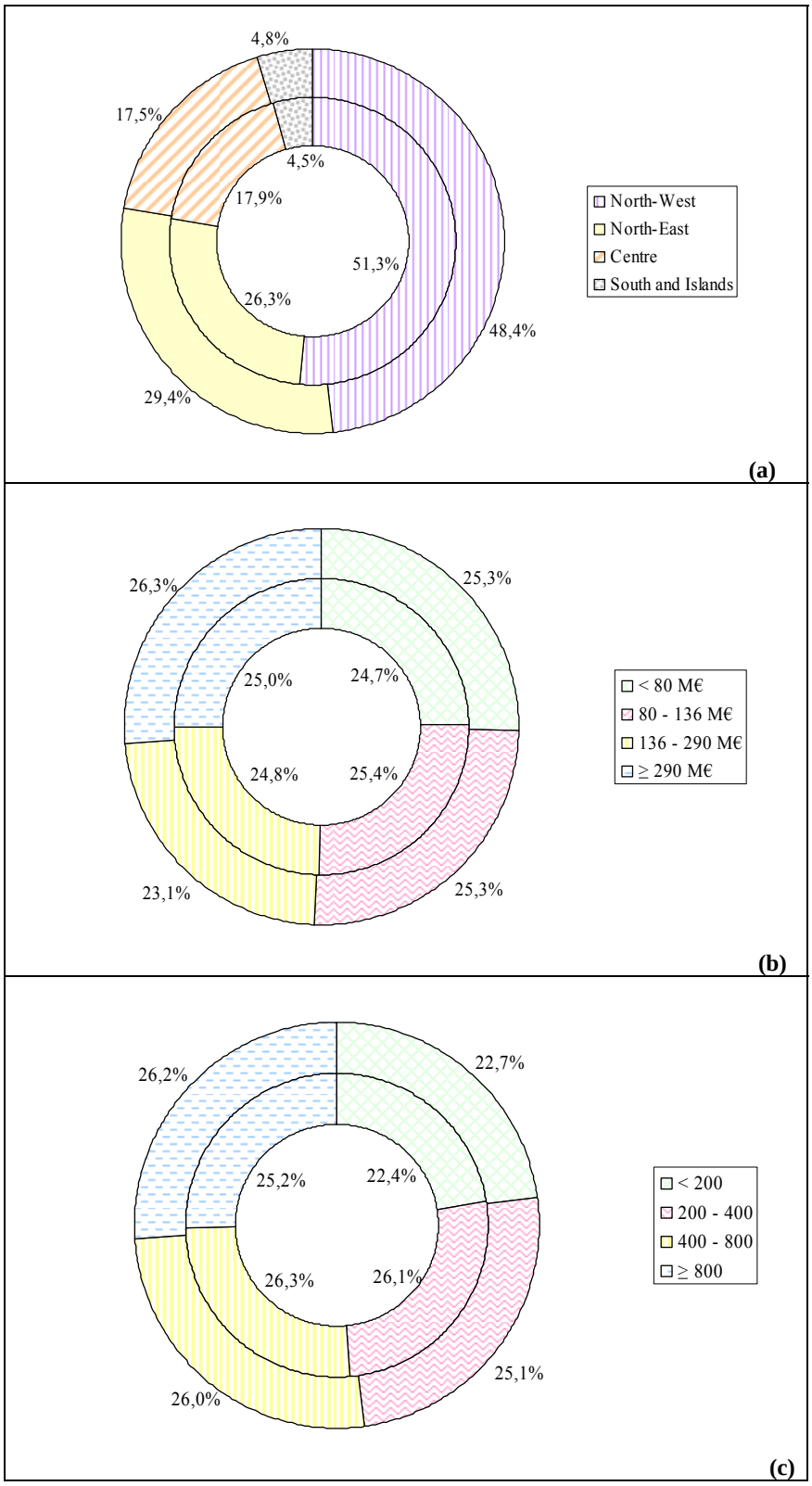

Figure 1 - population (inner ring) and sample (outer ring) distribution as to (a) geographic area, (b) turnover and (c) employees number

industry	population		sample		response rate
	frequency	*percent*	*frequency*	*percent*	
fashion	101	6,90%	41	8,90%	40,60%
chemical & pharma	230	15,80%	86	18,60%	37,40%
electro-mechanics	352	24,10%	127	27,40%	36,10%
iron	84	5,80%	28	6,00%	33,30%
transportation & logistics	51	3,50%	16	3,50%	31,40%
building & engineering	63	4,30%	19	4,10%	30,20%
food & beverage	153	10,50%	46	9,90%	30,10%
publishing & advertising	55	3,80%	11	2,40%	20,00%
public utilities	119	8,20%	15	3,20%	12,60%
other	250	17,10%	74	16,00%	29,60%
total	1458	100%	463	100%	31,80%

Table 2 - industry distribution for population and sample

Thus, our sample is well representing the population as to manufacturing firms, but also logistics providers and building and engineering companies, while the representativeness is lower as to publishing and advertising firms and public utilities providers.

The use of the Internet in B2B relations for Italian large companies is still quite scarce: only about 30% of the firms state that they use some internet-based tools with either suppliers or customers (Table 3).
Further, cross data (Table 4) show that firms using internet-based tools with half to lot of suppliers also use them with half to lot of customers.
The results seem to suggest that there is a large number of firms (107, equal to 23% of the whole sample) that is testing internet-based technologies with a selected number of partners and only a limited number of companies has already overcome the "testing phase", implementing such tools with a wider base of both suppliers and customers.

	suppliers				customers			
	freq.	*percent*	*valid %*	*cumul. %*	*freq.*	*percent*	*valid %*	*cumul. %*
none	125	27%	28%	28%	108	23%	25%	25%
few	196	42%	44%	72%	191	41%	44%	69%
half	37	8%	8%	80%	38	8%	9%	78%
lot	70	15%	16%	96%	77	17%	18%	96%
all	17	4%	4%	100%	18	4%	4%	100%
half to all	**124**	**27%**	**28%**		**133**	**29%**	**31%**	
total answers	445	96%	100%		432	93%	100%	
missing answers	18	4%			31	7%		
total	463	100%			463	100%		

Table 3 - number of supply chain partners with which an internet-based tool is used

		customers					
		no	few	half	lot of	all	total
suppliers	no	66	41	1	6	5	119
		55%	34%	1%	5%	4%	100%
	few	31	107	14	32	4	188
		16%	57%	7%	17%	2%	100%
	half	2	12	14	7	2	37
		5%	5%	5%	5%	5%	5%
	lot of	6	20	4	27	4	61
		10%	10%	10%	10%	10%	10%
	all	2	3	4	4	3	16
		13%	13%	13%	13%	13%	13%
	total	107	183	37	76	18	421
		25%	25%	25%	25%	25%	25%

Table 4 - supply chain partners with which an internet-based tool is used: cross data[2]

Tables 5 to 11 show the diffusion of internet-based tools - internet-EDI, XML systems and Extranets - in pre-sales, order cycle, logistics, billing, post-sales, monitoring and control and collaborative planning.
The diffusion is confirmed to be quite low, as no more than 16% firms state they use "a lot" internet-based tools for any activity.

pre-sales	not at all	little	rather	lot	**rather to lot**	missing answers
data alignment	38%	14%	13%	7%	**21%**	28%
product availability	32%	15%	18%	10%	**28%**	25%

Table 5 - use of the Internet in pre-sales activities

order cycle	not at all	little	rather	lot	**rather to lot**	missing answers
order emission	33%	15%	19%	16%	**35%**	17%
order confirmation	34%	16%	17%	13%	**30%**	19%
complex products congifuration	54%	11%	6%	5%	**10%**	25%
order change	42%	15%	13%	11%	**24%**	19%
order tracking	39%	12%	19%	11%	**29%**	19%

Table 6 - use of the Internet in order cycle activities

Order cycle is the process in which internet-based tools are most used (Table 6): 35% firms use them "rather" or "lot" for order emission, 30% for order confirmation and 29% for order tracking.

[2] Association between the two variables is high (gamma = 0.554) and statistically significant (p-value < 0.001).

logistics	not at all	little	rather	lot	**rather to lot**	missing answers
production planning	51%	11%	8%	5%	**14%**	24%
warehouse & handling	48%	13%	10%	6%	**16%**	24%
transportation planning	47%	16%	9%	3%	**12%**	25%
delivery tracking	39%	16%	18%	7%	**25%**	21%
delivery note	46%	16%	12%	4%	**16%**	22%
transportation documents	44%	14%	14%	6%	**20%**	22%

Table 7 - use of the Internet in logistics activities

billing	not at all	little	rather	lot	**rather to lot**	missing answers
billing	42%	15%	14%	8%	**22%**	21%
bills reconciliation	51%	11%	9%	5%	**15%**	23%
payment tracking	44%	13%	14%	6%	**20%**	23%

Table 8 - use of the Internet in billing activities

The diffusion of such tools is also quite high for the on-line check of product availability (28% "rather + lot", see Table 5), delivery tracking (25%, Table 7), billing and payment tracking (22% and 20%, Table 8) and reporting (26%, Table 10).

post-sales	not at all	little	rather	lot	**rather to lot**	missing answers
accounting information	45%	15%	8%	5%	**13%**	27%
warranties and claims	44%	16%	9%	6%	**15%**	25%

Table 9 - use of the Internet in post-sales activities

monitoring & control	not at all	little	rather	lot	**rather to lot**	missing answers
reports	37%	14%	18%	8%	**26%**	23%
alerts	44%	17%	10%	3%	**13%**	26%
quality management	43%	14%	13%	5%	**18%**	25%

Table 10 - use of the Internet in supply chain monitoring and control activities

collaborative planning	not at all	little	rather	lot	**rather to lot**	missing answers
VMI - CR - CPFR	46%	12%	8%	2%	**10%**	32%
event management	51%	12%	3%	0%	**4%**	33%

Table 11 - use of the Internet in collaborative supply chain planning activities

Integrated supply chain planning activities - such as vendor managed inventory, continuous replenishment and CPFR - are very seldom performed through the Internet (Table 11), as well as the configuration of complex products (10% "rather + lot", see Table 6).

Results suggest that the Internet is mainly used to support standard activities requiring simple and codified information sharing and only a very limited number of firms extend its use to complex activities.

process	rather to lot (mean value)
pre-sales	25%
order cycle	26%
logistics	17%
billing	19%
post-sales	14%
monitoring and control	19%
collaborative planning	7%

Table 12 - use of the Internet in supply chain management processes

The results are summed up in Table 12, where for each SCM process the mean value of the "rather + lot" answers for the different activities is reported. Data show that, even if the tools are not really widespread, not only execution processes - such as order cycle - but also strategic ones, such as supply chain monitoring and control, are covered.

As to expected performances, firms were asked to point out the first three from a list including:

- time and cost reduction;
- delivery improvement in terms of speed, flexibility, frequency and reliability;
- inventory and stocks-out reduction;
- customer care improvement;
- enhancement of innovation, customization and processes transparency.

Cost reduction is by far the most quoted answer, followed by process transparency enhancement and time reduction (Table 13).

	1st	2nd	3rd	1st + 2nd + 3rd
cost reduction	98	41	26	165
process transparency enhancement	41	37	47	125
time reduction	37	54	30	121
delivery reliability increase	18	26	27	71
inventory reduction	19	21	18	58
innovation enhancement	7	12	28	47
delivery speed increase	4	12	22	38
customization enhancement	9	16	9	34
customer care improvement	9	16	9	34
delivery flexibility increase	6	9	13	28
stocks-out reduction	8	10	9	27
delivery frequency improvement	1	3	3	7
other	4	0	0	4

Table 13 - expected performances achieved using the internet for SCM[3]

Thus, even if the very priority for firms implementing some internet-based tool is achieving better efficiency through costs and time reduction within their B2B transactions, higher processes transparency among partners is also a relevant issue: firms have understood that one of the greatest potentiality of the Internet is the streamlining of business processes achieved thanks to a better coordination of supply chain partners.

[3] Data refer only to those firms that have implemented some internet-based tool.

CONCLUSIONS

The paper reports some results of a survey concerning the use of internet-based tools for supply chain management in large Italian companies.
The use of tools such as internet-EDI, XML systems, web services and extranets for B2B transactions is still quite low, except for some activities mainly concerning order cycle. Yet, some strategic activities requiring the collaboration among supply chain partners are also supported.
The largest part of the sample use such tools only in a limited number of upward and downward relationships, probably implementing them within pilot schemes. Only a small number of firms has already overcome the testing phase and extended the use of the Internet for most of its B2B transactions.
Firms implementing some tool mainly search for cost reduction within their transactions, but processes transparency and streamlining is also a relevant issue for them.
Results seem to suggest that the implementation of internet-based tools for supply chain management is in a quite embryo stage, and most of the potentialities of the Internet are not seized yet.
This work is part of a wider research: a number of issues concerning the governance of supply chain relationships, even if considered in the whole study, are here neglected and further studies will be addressed towards them. In-depth case studies and industry deepening will also be performed in order to better understand the analyzed phenomena.

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