ORIGINAL PAPER

E-business strategy

How companies are shaping their supply chain through the internet

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Abstract

Purpose – This paper, originally published in 2003, aims to explore the actual adoption of internet technologies in supply chain processes.

Design/methodology/approach – The study is based on survey data from a large sample of European manufacturing firms participating in the IMSS survey.

Findings – The interest of both researchers and practitioners around the use of internet-based tools to support business processes has been quite high in the last few years. However, despite the initial enthusiastic expectations, it is still not completely clear whether these expectations have been translated into business reality. Results show a close link between the use of internet tools and the level of integration with customers and suppliers, thus suggesting the need to define e-business strategies in coherence with the use of traditional integration mechanisms.

Originality/value – Four e-business strategies are identified and their relationship with contingent factors and supply chain integration mechanisms is investigated.

Keywords Internet, Operations and production management, Competitive strategy, Supply chain management

Paper type Research paper

Introduction

It is widely acknowledged that companies are increasingly facing the challenge of e-business, that is, the use of internet-based tools to support their business processes. In fact, the evolution of Information and Communication Technology has fostered the development of powerful tools that are expected to improve supply chain performance dramatically, through higher levels of process efficiency and integration. Despite the initial enthusiastic expectations, it is still not completely clear how relevant these technologies are for companies and what actual benefits can be obtained. In fact, there is still poor evidence of actual implementation and effectiveness of e-business practices. Some results of existing research in the field, although preliminary, seem to highlight as a success factor of e-business choices their coherence with the overall strategy of the company. Following this line of reasoning, it is interesting to study how e-business practices are used and integrated in the operations strategy as a whole, in order to understand their coherence and the consequent potential benefits. However, operations management research still lacks empirical results that examine the relationship between e-business and supply chain strategies.

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This paper aims at addressing the above issues, providing some evidence of the use of internet tools by a sample of European manufacturing companies. Such tools aim at supporting different supply chain processes, in relationship with different supply chain strategies.

Research background

The use of electronic communication links between firms has been considered as a key tool for at least 20 years. Malone *et al.* (1987) argue that electronic communication along with supply chain allows the reduction of both the costs of coordinating economic transactions and the costs of coordinating production. EDI was the first tool that was widely diffused and enabled this kind of communication, while more recently internet-based applications seem to overcome most of its original limitations.

The increasing importance and role of web-based technologies to support company operations (e-business) is widely acknowledged both by practitioners (e-business reports have been published by all of the more important consulting firms – such as Forrester Group, Gartner Group, Morgan Stanley, KPMG, Accenture, etc.) and academicians (Evans and Wurster, 1999; Skjoett-Larsen, 2000). The efficiency of information transfer, the timeliness of information availability, the openness and transparency of relevant business information are only a few of the benefits provided by the internet to support supply chain integration. E-business is particularly important for the supply chain literature as a consequence of the increasing need to integrate activities and information flows and to optimize the processes not only at the single company level, but also at the level of inter-company processes (Stevens, 1989). In fact, an increasing amount of activities are externalized, thus their impact on company processes should be managed through adequate integration mechanisms in order to foster superior performance (Hakansson and Snehota, 1995).

In the previous years, a surprising number of studies appeared in the management literature, trying to describe and better understand the e-business phenomenon, mainly exploring the potential advantages, the changes required in current management and organization of the companies, the possible business models of adoption of internet tools. Most of these studies were explorative in nature, and mainly conducted through case study approaches (Van Hoek, 1998, 2001a). However, they helped to provide a more mature view of relevant features and potential of the internet, compared to the first, enthusiastic claims on the "miraculous" effects of the "new economy".

One of the points that was clarified is that the concept of e-business itself is rather wide, since it includes a number of different applications and uses of the internet technology.

Among the possible classification dimensions, a relevant one is based on the process supported by internet tools. In fact, supply chain management refers to the management of different processes, such as customer relationship management, customer service, demand management, order management, production and material flows and purchasing (Lambert *et al.*, 1998). In this light, internet tools can be classified as: *e-commerce* (Brynjolfsson and Smith, 2000) – support to sales, distribution and customer service processes, *e-procurement* (De Boer *et al.*, 2002) – support to sourcing, procurement, tendering, and order fulfillment processes, and *e-manufacturing* (Kehoe and Boughton, 2001) – supporting demand and capacity planning, forecasting and internal supply chain integration. Another classification is suggested

by Lee and Whang (2001), who distinguish between *e-commerce, e-procurement* and *e-collaboration*. The last category refers to the use of the internet to strengthen the relationships along the supply chain, exchanging data and making joint decisions. Frohlich and Westbrook (2002) classify web-based supply chain integration strategies according to two dimensions, namely internet-based demand and supply integration. The resulting categories are *low integration, demand integration* (similar to e-commerce), *supply integration* (similar to e-procurement) and *demand chain management integration* (which is the joint application of the previous two strategies).

Moreover, different tools and solutions have been implemented through the use of internet technologies, each with different goals, benefits and drawbacks. For example, relevant differences exist between auctions, exchanges, marketplaces, catalogues, e-collaboration tools, etc. (Kalakota, 2000; Kaplan and Sawhney, 2000; Wise and Morrison, 2000). Finally, distinctions between tools have been made also on the basis of the connectivity model, i.e. between private and public tools (Whitaker *et al.*, 2001).

The attention of the companies and the literature was first concentrated on the use of the internet to support sales and customer service to end-users (Van Hoek, 2001b), e.g. business-to-consumer *e-commerce*. However, much greater potential has been expected from the business-to-business applications, especially the ones aiming at automating, speeding-up and facilitating information flows along the supply chain (Feeny, 2001). Van Hoek (2001a) suggests that the supply chain dimension of e-business has been neglected so far, as poor basic operational performance is hampering the implementation and success of such applications.

Given this variety of tools and applications, the literature highlighted that companies can draw benefits from the use of internet tools only by defining a clear e-business strategy.

The concept of e-business strategy has been introduced to address the issue of how the internet can reshape companies and provide competitive advantage. Contributors covered different perspectives of the problem, ranging from business models to organization, and from marketing to operations (Brynjolfsson and Urban, 2001, for a review). In the specific context of Supply Chain Management, e-business strategy refers to the way internet tools are selected and used in relation to the needs of integration. A coherent e-business strategy concerns both the right choice of tools and solutions according to the specific aims, goals and context of the application (Soliman and Youssef, 2001), and the coherence of these choices with other organizational and managerial tools used to integrate the company's processes (Graham and Hardaker, 2000). The need to integrate organization and technology is relevant, in general, for most technological innovations, in particular those related to information technology. Just to give an example we remind here what happened with the introduction of computer integrated manufacturing (CIM), whose results did not match expectations, often due to the lack of understanding of the strategic, cultural and organizational changes that were required to achieve its potential (Cagliano and Spina, 2000).

Finally, the company and the whole supply chain may require or take advantage of relevant structural changes concurrent with e-business adoption, such as streamlining, reduction in number of tiers, changes in power structure, etc. (Croom, 2001; Malone *et al.*, 1987; Sampler, 1998). Consequently, a successful e-business implementation requires both a coherent set of different tools and relevant structural changes, leading to an integrated approach that involves both the physical and the virtual supply chain,

as shown by very few successful cases studied so far (Graham and Hardaker, 2000; Van Hoek, 1998, 2001a).

Although these points are reasonably well established, the discipline is still in its early stages, thus requiring further investigation and fine-tuning. In particular, large empirical studies are needed that try not only to describe the current behaviors of companies when facing the internet, but also studying relationships among the relevant variables of the problem (Van Hoek, 2001b).

Considering the above-mentioned points, some relevant matters should be addressed:

- Do companies adopt internet in different processes across the supply chain through a comprehensive e-business strategy, or do they focus on the most relevant ones in their contingent situation?
- Which contingent variables are relevant to explain higher or lower use of the internet, or different e-business strategies?
- Are companies adopting e-business strategies in coherence with their overall supply chain strategy? In other words, is there coherence between the e-business strategies adopted and the integration mechanisms used across the supply chain?

The understanding of these aspects is very important for the development of a new theory of supply chain management that includes internet tools as relevant variables, rather than studying them separately.

Research aims and propositions

The aim of this paper is to investigate the use of the internet by manufacturing companies to integrate processes along the supply chain, and to analyze the relationships among internet adoption, contingent factors and integration mechanisms. The underlying assumption is that effective use of internet technologies to support the current business takes place only when it is integrated in coherent strategies of supply chain management.

The first research objective is to understand the extent to which the internet is currently adopted by European manufacturing firms in the operational processes along the supply chain. The second is the identification of the contingencies that affect the use of the internet currently, in order to investigate in which contexts the expected benefits are higher. Finally, to better understand if specific relationships exist, this paper analyses which coordination mechanisms are coherent with the use of the internet within the supply chain.

The following research propositions will be explored.

P1. The internet is adopted by manufacturing firms to integrate different processes along the supply chain; different e-business strategies can be identified according to the process in which internet is used.

P2. The e-business strategy selected by the company is influenced by contingent factors such as industry, size and the position within the supply chain.

P3. E-business strategies are related to the mechanisms used to coordinate the supply chain; in particular, coherent patterns of technological and managerial integration can be identified.

The relationships among the variables hypothesized in the above propositions are shown in Figure 1. The dotted line represents a relationship between contingent factors and integration mechanisms, which could exist, although it is not considered in the present work, since it is not relevant for the purpose of the research.

Research methodology and sample

The sample

This study is based on survey data collected within the third release of the International Manufacturing Strategy Survey (IMSS III), a research carried out by a global network aimed at exploring practice and performance in manufacturing and supply chain management (see the Appendix for an extract from the questionnaire) (Lindberg *et al.*, 1998).

Data were collected during 2001 by national research groups using a standard questionnaire, developed by a panel of experts on the base of the state-of-the-art of both research and practice, exploiting also the experience of the previous editions of the research. In nations where English is not commonly used, the questionnaire was translated into the local language by OM professors familiar with manufacturing and supply chain strategy.

This study is based on the European sample of IMSS III; the average response rate in the various countries was 34 percent. Among the 338 companies of the sample, only 276 provided enough information for the purpose of this study. Companies in the sample operate in the engineering industry (ISIC 38 classification) and employ more than 15 persons.

Small companies (from 15 to 250 employees) account for 48.9 percent of the sample, medium-sized companies (from 251 to 500 employees) account for 20.3 percent, while large companies (more than 500 employees) account for 30.8 percent.

The distribution of the sample by country and industry is shown in Tables I and II.

The variables included in the analysis

As mentioned in the previous section, this study focuses on the impact of the internet on supply chain strategy, and in particular on operational integration. In order to obtain an overall supply chain perspective, the variables used address both up- and down-stream operations.

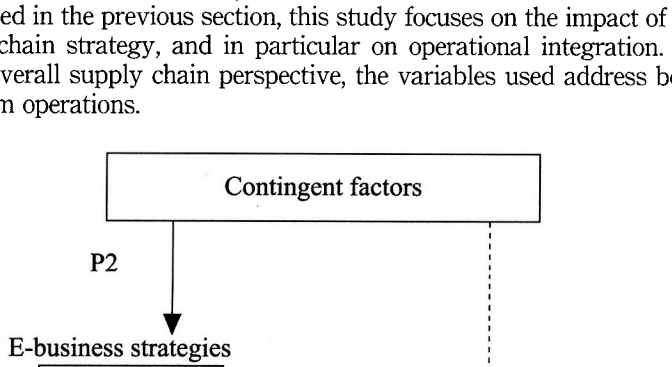

Figure 1.
Framework of the research propositions

Three categories of variables have been considered for the analysis:

(1) the degree of use of the internet to integrate processes along the supply chain;

(2) the coordination mechanisms along the supply chain; and

(3) the contingent variables.

While the first of these three categories of variables was used to identify configurations based on the use of the internet, contingent variables and coordination mechanisms were used a posteriori to describe the configurations detected and to study external consistency. The specific variables were chosen according to classifications commonly accepted in the literature both for the processes that can be supported by the internet and for the coordination mechanisms.

Most variables were measured on Likert-like scales from 1 to 5. Some variables are categorical (industry – ISIC code, country) or numerical (e.g. company size). The original questions from the IMSS questionnaire can be found at the end of this paper.

Research methodology and constructs

The first step of the analysis has been the reduction of many variables available through factor analysis, in order to highlight the main underlying constructs. The second step has been the classification of the sample into groups through cluster analysis, in order to highlight different e-business strategies, thus testing *P1*. Finally, the third step has been the analysis of the relationships among e-business strategies, contingencies and coordination mechanisms, in order to investigate both *P2* and *P3*.

Factor analysis has been performed within both the areas of adoption of the internet and the coordination mechanisms. In particular, a Principal Components Analysis with Varimax Rotation has been performed in order to minimize inter-factor correlation.

Table I.
Geographical distribution of the sample

Country	*n*	Percent
Denmark	34	12.3
Germany	28	10.1
Hungary	53	19.2
Ireland	27	9.8
Italy	55	19.9
Norway	20	7.2
Spain	17	6.2
UK	42	16.2

Table II.
Industry distribution of the sample

ISIC	Industry	*n*	Percent
381	Fabricated metal products	77	27.9
382	Machinery except electrical	75	27.2
383	Electrical machinery apparatus, appliances and supplies	73	26.4
384	Automative and transportation equipment	30	10.9
385	Measuring and controlling equipment	21	7.6
	Total	276	100.0

This methodology helped to reduce the problem of multicollinearity among variables, which can decrease the significance of cluster analysis on the variables (Ketchen and Shook, 1996; Punj and Stewart, 1983). The number of factors has been determined according to the analysis of the combination of components' eigenvalues, percentage of variance explained and orthogonality of the solution obtained (Norusis, 1993). Cronbach's α coefficient is used to measure construct reliability (Fullerton and McWatters, 2001; Nunnally, 1978).

Measure for internet adoption within the supply chain

The internet adoption within the supply chain has been assessed by asking companies the following question: "To what extent do you use internet to integrate the activities of the following processes along the supply chain?". The answers to this question were given on a five-point scale ranging from "no use" (1) to "high use" (5) and have been grouped in three factors, explaining 77 percent of the total variance. Generally, only components with eigenvalues greater than 1 are chosen, but in this case only one component presented such a value. This is because only a limited number of companies in the sample (123 out of 276, i.e. 44.6 percent) did adopt e-business. Consequently, at a first analysis, the processes involved in internet adoption could be considered as a single factor. However, since the purpose of the present work is to investigate the different strategies of adopters, a three factors solution has been chosen, according to both interpretability and orthogonality criteria, thus allowing to explain a greater amount of the total variance (77 percent compared to 56 percent). This solution, as shown in Table III, presents factors with loadings greater than 0.6 and no variable has loadings greater than 0.45 on more than one factor (Bagozzi and Yi, 1988). The value of Cronbach's α is greater than 0.7 for all factors, showing high reliability of the constructs.

The emerging factors concerning the use of the internet have been labeled *e-commerce*, *e-procurement* and *e-operations*. The first refers to sales and customer service and support, thus representing the adoption of e-business in downstream relationships. The second factor refers to the use of the internet in purchasing activities, including procurement of both strategic and standard parts. In this case, the

Variables	Factor loadings E-commerce	E-procurement	E-operations	Mean
Customer service and support (CRM)	0.87	–	–	1.92
Sales	0.76	–	–	2.06
Procurement of strategic parts	–	0.90	–	1.90
Procurement of standard parts	–	0.85	–	1.97
Order processing and tracking	–	–	0.80	1.74
Production planning and scheduling	–	–	0.79	1.49
Inventory management	–	–	0.69	1.49
transportation planning	–	–	0.62	1.72
Cronbach's α	0.74	0.86	0.85	–
Averag use	1.94	1.90	1.60	–
Standard deviation use	1.04	1.07	0.84	–
average payoff (adopters)	2.98	2.84	2.88	–
standard deviation payoff (adopters)	100	1.07	0.91	–

Note: Factor loadings in excess of 0.45 are shown

Table III.
Factors measuring internet adoption to integrate processes in the supply chain

internet is adopted to manage upstream relationships with suppliers. The third factor, finally, refers to the use of the internet in the operational activities across the company value chain, including order processing and tracking, production planning and scheduling, inventory management and transportation planning. This factor represents the adoption of the internet in all those processes which, although dealing with physical and information flows along the supply chain, are mainly focused on internal operations. These three factors are consistent with the constructs used in the literature (Brynjolfsson and Smith, 2000; De Boer *et al.*, 2002; Frohlich and Westbrook, 2002; Kehoe and Boughton, 2001; Lee and Whang, 2001).

Measure for coordination mechanisms

The use of the coordination mechanisms has been investigated both up- and down-stream, coherently with what has been done for internet adoption, through the following question: "How do you coordinate planning decisions and flow of goods?". Respondents used a five-point scale ranging from "no use" (1) to "high use" (5). Factor analysis has been performed separately for the variables related to the interface between customers and suppliers. The variables considered are consistent with those used to measure supply chain integration in other studies (Frohlich and Westbrook, 2001). The results, as can be seen in Table IV, show two factors in each case, very similar in their composition. The first factor, named *information sharing*, refers to the exchange of information on production plans, delivery frequencies and inventory levels. The average use of these mechanisms is quite high, although the standard deviation suggests some differences in adoption. The second factor, *system coupling,* consists of the adoption of tools and techniques, such as VMI, kanban and co-location, aimed at coupling the interface between customer and supplier. The average use of these mechanisms, instead, is quite low, but there are a few firms that adopt them to a much greater extent, as shown by the high standard deviation. Although the two factors are not identical up- and down-stream, they have been named in the same way, since the relevant content is very close.

In the second step of the analysis, the sample has been subdivided into clusters based on the three factors, corresponding to the areas of adoption of e-business, in order to highlight different patterns of adoption of the internet. The approach is similar to the one adopted in literature on *strategic configurations,* which aims at individuating

	Coordination with suppliers			Coordinate with customers		
Mechanisms	Info. sharing	System coupling	Mean	Info. sharing	System coupling	Mean
Production plan	0.832	–	3.33	0.849	–	3.13
Delievery frequency	0.738	–	3.77	0.745	–	3.54
Inventory levels	0.6777	–	2.89	0.706	–	2.75
VMI	–	0.754	2.30	–	0.832	2.21
Co-location	–	0.636	1.78	–	0.682	1.78
Std packages	–	0.571	2.80	0.555	–	2.87
Kanban	–	0.537	2.24	–	0.611	1.90
Cronbanch's α	0.680	0.559	–	0.749	0.614	–
Mean	3.36	2.27	–	3.12	2.02	–
Standard deviation	0.91	0.83	–	1.02	0.96	–

Note: Factors loading in excess of 0.45 are shown

Table IV.
Factors related to coordination mechanisms with suppliers and customers

groups of companies whose strategies are very similar within the same cluster and different from those of the rest of the sample (Bozarth and McDermott, 1998; Frohlich and Dixon, 2001; Miller and Roth, 1994). Given the aim of the present study, the most appropriate variables to identify e-business strategies are the different approaches to internet adoption within the supply chain.

Hierarchical cluster analysis using Ward's partitioning method and squared Euclidean distance allowed the determination of the most suitable number of clusters, while a non-hierarchical technique (the K-means algorithm) was chosen to assign each company to a cluster, through an iterative process. This two-step approach is suggested to exploit the advantages of both techniques (Ketchen and Shook, 1996). The number of clusters was determined considering both the increase in the agglomeration coefficient while reducing the number of clusters and the interpretability of the solution obtained. The greatest increase in the coefficient corresponds to the aggregation of all cases from two to one cluster, thus collapsing together adopters and non-adopters of e-business. This means, as mentioned earlier, that the most significant difference between the companies in the sample is between these two macro categories. However, in order to explore different e-business strategies, a four-cluster solution was chosen, corresponding to the second highest increase in the difference between the agglomeration coefficient in two consecutive solutions. Also the interpretability criterion confirmed the choice, since passing from five to four clusters, two quite similar groups merged, while passing from four to three the merging involved two dissimilar groups. To validate the four-group solution, a test of equality of group means (ANOVA) was performed, showing that all variables differ significantly across the clusters. Discriminant analysis was run to ensure that the groups were correctly classified: the analysis shows very good differentiation among the groups (Miller and Roth, 1994).

Finally, ANOVA, *post hoc* and Pearson Chi-squared tests have been used to detect the links between e-business strategies, contingent settings and coordination mechanisms.

Results

The use of the internet in manufacturing firms

As mentioned earlier, the first step of the analysis has been the investigation of e-business adoption. As seen in Table III, the average use of the internet is very low, due to a high number of companies not adopting it at all, and a limited number of companies adopting it to a high extent (as shown by the high standard deviation). This is consistent with the literature, which shows that only some firms have actually adopted the internet (Van Hoek, 2001b). In particular, one can see that the adoption of the internet is higher in downstream and upstream processes (e-commerce and e-procurement), while is lower within the company (e-operations).

For the firms that do use the internet, the payoff is, on average, on intermediate values (almost 3 on a five-point scale), but with a certain variability (standard deviation around 1). This means that there is a sub-set of firms that actually use the internet and have obtained rather good results from it, although they are a minority of the sample.

E-business strategies

The above results suggest that there are different degrees of adoption of the internet and, besides that, it can be used to integrate different processes. Consequently, firms were grouped in four categories using cluster analysis, in order to highlight different

e-business strategies, each one characterized by the adoption of the internet in different areas. The discriminant analysis showed that the clustering algorithm classified 98.9 percent of the companies correctly, indicating very good differentiation among the clusters. The *post hoc* test, using the Scheffé method, showed that the difference between each pair of cluster is statistically significant for each of the three factors, with only one exception. The results of the cluster analysis are shown in Tables V and VI.

The four clusters obtained through the analysis are discussed in the following sections.

Traditionals

This is the largest group in our sample, with no relevant use of internet-based technologies within the supply chain. In fact, the three e-business factors are significantly lower than in every other cluster. Having detected that this group is coherent with the preliminary results about e-business adoption and with the common understanding that the internet has generated considerable discussion and promised much, but, as yet, has only been adopted by a relatively small number of firms. The data were collected during 2001, thus it is possible that in the subsequent years, more companies within this group have adopted e-business. However, given the end of the "new economy" hype and the economic downturn, the situation is not likely to have dramatically changed. In our sample, this group accounts for about 55 percent of the companies.

E-sellers

This cluster contains 64 firms adopting the internet mostly for sales and customer care. The e-commerce factor is in fact significantly higher than traditionals and e-purchasers.

	Clusters				
Factors	1 Traditionals	2 E-Sellers	3 E-purchasers	4 E-integrators	ANOVA sig.
E-commerce	1.30	2.99	1.74	4.18	0.00
Pairwise difference	(2, 3, 4)	(1, 3, 4)	(1, 2, 4)	(1, 2, 3)	–
E-procurement	1.31	1.81	3.43	3.99	0.000
Pairwise difference	(2, 3, 4)	(1, 3, 4)	(1, 2, 4)	(1, 2, 3)	–
E-operations	1.15	1.96	1.76	3.60	0.000
Pairwise difference	(2, 3, 4)	(1, 4)	(1, 4)	(1, 2, 3)	–
No. of firms	153	64	39	20	–
Percent	55.4	23.2	14.1	7.3	–

Note: Pairwise differences shown are significant at the 0.05 level (*post hoc* test using the Scheffé)

Table V.
Clusters obtained on the base of internet adoption factors

	E-commerce	E-procurement	E-operations
E-sellers	3.18	–	–
E-purchasers	–	3.38	–
E-integrators	4.12	3.67	3.83

Note: The difference in the e-commerce payoff between e-integrators and e-sellers is statistically significant at the 0.01 level

Table VI.
Payoff of the adoption of the internet

This group is fairly large (23 percent of the sample) and this is in line with indications provided by the literature. The use of the internet mainly for sales and customer care has been seen, especially at the beginning of the "new economy", as the most frequent approach to the adoption of the internet (Van Hoek, 2001a, b). Anyway, we cannot conclude that this is necessarily the best strategy for companies; it will be interesting to observe whether firms in this group will go on in this direction or if they will instead move to other strategies. A first indication in this direction comes from the fact that, while the e-procurement factor is lower than in any other group except traditionals, e-operations is higher (even if not significantly so) compared to e-purchasers. This fact suggests that these companies are also integrating their internal processes related to e-commerce.

E-purchasers

This group includes 39 firms (14 percent of the sample) adopting the internet to a significant extent only for one upstream process within the supply chain, namely purchasing. In fact, e-procurement is significantly higher than in every other group, except e-integrators, the other factors being significantly lower. This means that e-procurement is seen as a practice with which companies can start introducing the internet, without relevant investments in other areas.

E-integrators

This cluster includes 20 firms adopting the internet in all the processes of the supply chain, from procurement to sales, including internal operations. This is the smallest group (7 percent), and includes the most advanced firms as far as internet adoption is concerned, since they adopt web-based solutions to a high extent along the whole supply chain (the value of the three factor is significantly higher than in every other group). internet adoption in this cluster seems to be most coherent, since technology supports the integration of the whole supply chain. Clearly, only a limited number of companies have adopted this integrated approach as yet, which is in line with the suggestions provided in the literature for achieving the best results (Van Hoek, 2001a, b).

General comments

It is interesting to note that, as could be expected, the companies which actually use the internet have also quite higher payoffs in the processes involved, compared to non-adopters. Besides, e-integrators also have a higher payoff than e-sellers from e-commerce, suggesting the higher effectiveness of a fully integrated strategy.

As a general comment, it is interesting to note that the use of the internet to support internal operations is only used together with both e-commerce and e-purchasing, to obtain overall supply chain integration, while it is only used in a limited way to support integration downstream. One can expect some sequence or path of internet adoption, depending on the ease or benefits obtained by each strategy.

Further insights on this subject can be derived from Table VI, which shows the declared future adoption of the internet.

The first impression is of a general tendency towards an increase in internet adoption, in particular, each group seems to go on in the same direction followed so far; the three strategies, in fact, are still clearly the same. The comparison of the values, however, could also suggest that both e-purchasers and e-sellers tend to widen their

strategies, investing also on other processes, suggesting the possibility of an evolutionary path towards e-integrators. Considering the differences between future and current adoption, indeed, some interesting observations can be made. The greatest increase is declared by e-purchasers in the e-commerce area (+1.19), while the second greatest by e-sellers in e-procurement (+0.90), and both groups are also similarly planning to adopt e-operations (+0.63 for e-purchasers and +0.66 for e-sellers). This means that those companies, who have so far adopted e-business in limited areas of the supply chain, are trying to close the gap with e-integrators, who however, are not standing still, since they are planning to strengthen all the areas, in particular e-operations (e-commerce +0.44, e-procurement +0.30, e-operations +0.51). Firms belonging to the traditionals group are also moving, declaring higher adoption, in particular for e-commerce (+0.76) and e-procurement (+0.62). It seems likely that new adopters are starting from one single area (e-commerce or e-procurement), to move subsequently to wider adoption strategies.

The effect of contingencies on the adoption of the internet

The clusters presented in the earlier section have been analyzed, considering contingent factors, such as industry, size and position in the supply chain. The results presented in Tables VII-X highlight some interesting differences among the groups, although only the industry factor is statistically significant (Pearson Chi-Squared test).

The contingencies that characterize each cluster are discussed in detail.

Table VII.
ANOVA of the future adoption of the internet

	Traditionals	E-sellers	E-purchasers	E-integrators	Sample mean	Sig.
E-commerece	2.06	3.73	2.94	4.63	2.80	0.000
E-procurement	1.93	2.71	4.01	4.29	2.61	0.000
E-operations	1.53	2.62	2.39	4.11	2.13	0.000

Table VIII.
Industry distribution of the clusters

ISIC	Traditionals (percent)	E-sellers (percent)	E-purchasers (percent)	E-integrators (percent)	Sample (percent)
381	30.1	20.3	38.5	15.0	27.9
382	26.1	35.9	23.1	15.0	27.2
383	24.2	28.1	17.9	55.0	26.4
384	15.0	6.3	2.6	10.0	10.9
385	4.6	9.4	17.9	5.0	7.6
Sig.	0.004	–	–	–	–

Table IX.
Size distribution of the clusters

Size	Traditionals (percent)	E-sellers (percent)	E-purchasers (percent)	E-integrators (percent)	Sample (percent)
Small	51.6	48.4	53.8	20.0	48.9
Medium	19.6	20.3	20.5	25.0	20.3
Large	28.8	31.3	25.6	55.0	30.8
Sig.	0.170	–	–	–	–

Traditionals
The companies that are not using internet technologies in the supply chain are rather dispersed, there is no contingent setting without a relevant presence of this group of firms. This approach seems to be still very diffused, irrespective of industry, size or position in the supply chain. Anyway, traditional firms are more concentrated in the automotive and transportation (384) and less in the measuring and control equipment industry (385), compared to the sample distribution. As far as size is concerned, this group of companies does differ significantly from the total sample. Considering the position in the supply chain, finally, the firms that do not use the internet are more concentrated upstream and less downstream.

E-sellers
Companies that adopt the internet mainly in the selling process are concentrated in the machinery industry, while their presence is limited to both the metal products and the automotive and transportation industries. There are slightly more large firms than small ones, but the size distribution in this category is very similar to the total sample. No relevant differences with the sample can be found when considering the position in the supply chain either, although it seems that they are slightly more concentrated in intermediate positions.

E-purchasers
Companies that use the internet mainly in the procurement process are strongly concentrated in the metal products and measuring and control equipment industries (381 and 385), with a very low presence in the electrical machinery and automotive and transportation ones (383 and 384). This group shows the highest concentration of small firms and the lowest presence of medium and large ones, which is a very interesting result, meaning that the internet is both feasible and actually adopted by SMEs. Finally, e-purchasers are concentrated in the downstream stages of the supply chain. This is not surprising, since companies at these stages rely strongly on their suppliers, and with purchasing consequently being a strategic process, the use of internet technologies can provide relevant benefits.

E-integrators
The firms that use the internet in all the supply chain processes are strongly concentrated in the electrical machinery industry, with a low presence in both the metal products and

Position	Traditionals (percent)	E-sellers (percent)	E-purchasers (percent)	E-integrators (percent)	Sample (percent)
Upstream	34.6	25..6	31.3	20.0	31.5
Intermediate	9.2	5.1	9.4	5.0	8.3
Downstream	54.9	64.1	56.3	75.0	58.0
Missing	1.3	5.1	3.1	0.0	2.2
Sig.	0.656	–	–	–	–

Note: *Upstream*: 70 percent or more of sales to component manufacturer or product assembler; *Downstream*: 70 percent or more of sales to distributors or end users; *Intermediate*: less than 70 percent of sales to both groups

Table X.
Distribution of the position in the supply chain of the clusters

the machinery industries, although the limited dimension of this group (20 companies) does not allow to generalize this result. Also considering size there is a relevant polarization towards large firms, with a marginal presence of small ones; this result anyway is not surprising, given the investment required by such a pervasive use of e-business. The position in the supply chain, finally, is also strongly shifted downstream.

General comments. In synthesis, the analysis of contingencies shows that only industry has a statistically significant impact, but all the factors considered present differences among the clusters.

The companies in the sample belonging to the automotive industry are the ones with the lowest adoption of the internet. This is rather surprising, since this industry is usually technologically highly developed and relies strongly on supply chain processes. Maybe the high diffusion of EDI has hampered the penetration of web-based technologies. The companies in the metal products and in the measuring and control equipment industries are mainly focused on the procurement process. Those in the machinery industry are focused on the selling process, while the electrical machinery is the industry with the highest rate of e-integrators.

Small firms either adopt the internet for the procurement process or they do not use it at all, while large firms can more easily afford a pervasive use, involving all the three main processes.

Companies operating upstream in the supply chain generally show the lowest use of the internet, while those operating downstream are more likely to adopt it, in particular for the procurement process, in some cases even for all processes together.

E-business strategies and supply chain integration mechanisms

The last step of the analysis has been the investigation of possible relationships between the adoption of e-business and the coordination mechanisms used to integrate the supply chain, which could be supported by the internet, but could also be implemented through more "traditional" technologies. The factor analysis (see previous section) highlighted the same mechanisms both up- and down-stream: information sharing, based on an intense exchange of information between the customer and the supplier, and *system coupling,* which consists of practices such as VMI, kanban, and co-location.

The use of these mechanisms by the different groups of firms has been investigated through ANOVA and *post hoc* tests, and the results are presented in Table XI.

From the data, we can observe that information sharing is a common integration mechanism, used by all groups of firms, both adopters and non-adopters of the internet. This clearly means that a lot of companies still rely on traditional tools and methods to exchange information with their customers and suppliers. However, the companies that do use the internet show higher values of information sharing with suppliers, thus supporting the idea that the internet enforces communication. The *post hoc* test shows that e-integrators use these mechanisms significantly more than the firms belonging to the traditional cluster. In general, e-integrators show the highest use of information sharing. This first result suggests that e-integrators are the companies that have closer relationships with their partners, and that the use of the internet seems to be aimed at facilitating them.

System coupling, both up- and down-stream, is lesser spread than information sharing. Some differences exist between traditionals and internet adopters, even if they

	Traditionals	E-sellers	E-purchasers	E-integrators	Sample	Sig.
Info. sharing suppliers	3.19	3.48	3.53	3.84	3.36	0.004
Pairwise difference	(4)	–	–	(1)	–	–
System coupling suppliers	2.13	2.36	2.23	3.06	2.27	0.000
Pairwise difference	(4)	(4)	(4)	(1, 2, 3)	–	–
Info. sharing customers	3.06	3.09	3.14	3.55	3.12	0.271
Pairwise difference	–	–	–	–	–	–
System coupling customers	1.86	2.04	2.16	2.82	2.02	0.000
Pairwise difference	–	–	–	(1, 2)	–	–

Note: Pairwise differences shown are significant at the 0.05 level (*post hoc* test using the Scheffé)

Table XI.
ANOVA of the factors related to coordination mechanisms

are not significant, with the exception of e-integrators. This result suggests that often internet adoption is aimed at supporting market transactions, with tools such as auctions, catalogues and marketplaces, instead of collaboration. E-integrators, instead, employ system coupling at the highest level, suggesting a relationship between the adoption of advanced coordination mechanisms and the pervasive use of the internet. The *post hoc* test shows that the adoption of system coupling with suppliers by e-integrators is significantly higher than any other group in the sample, and system coupling with customers is also significantly different from both traditionals and e-sellers. This result reinforces the idea that e-integrators are the companies that have developed close, collaborative relationships along the supply chain and are thus using the internet along with traditional integration mechanisms to obtain better coordination and support collaboration. This interesting result should be further analyzed, since the limited number of firms in this group does not allow for generalization. The general characteristics of this cluster, which is made up mostly by large firms, seem to be relevant in explaining this strategy, which indeed requires considerable investments and significant process re-engineering.

Finally, the analysis has shown a relationship between e-business strategies and integration mechanisms, suggesting that integrated strategies do exist. In particular, e-business is adopted in at least one supply chain process by those companies that share information with partners, confirming the synergy between the two. Instead if we consider those companies that use the internet throughout their supply chain (e-integrators), we notice that they both exchange information to a high extent and closely integrate their systems with their partners. This is a new supply chain strategy, which requires a radical redesign, but is also expected to provide the highest benefits, since it is based on a coherent set of choices, and not just on the automation of the existing processes.

Conclusions

The study presented in this paper highlighted the existence of different e-business strategies among those companies that have adopted web-based solutions to integrate their supply chains, strategies that differ in terms of the processes supported by internet applications. A few studies have already proposed some classification of e-business applications, but they are generally based on conceptual categories or case studies of

best practices. The present work, instead, is based on survey data, consequently the strategies identified are those currently adopted by a relevant European sample. These strategies have been explored both in terms of impact of contingent factors and relationship with other supply chain coordination and integration mechanisms. In this way each strategy has been defined considering not only the supply chain processes supported by e-business, but also the related use of information sharing and system coupling mechanisms with both customers and suppliers.

The value of the present study is twofold. On the one hand, it contributes to current research presenting a taxonomy of strategies based on-empirical data, on the other, it provides useful insights for managers.

The evidence discussed in this paper shows that both partial adoption of the internet on a few processes and complete adoption throughout the supply chain are used by companies. The former strategies, although presenting satisfactory payoffs, seem to be a transition state. In fact, on average these companies plan to extend the use of the internet to other processes. The study also showed how few companies that have implemented e-business solutions extensively, i.e. throughout the supply chain, are now achieving far better payoffs. This strategy thus seems to be superior in terms of effectiveness. Interestingly, the empirical evidence shows that this extensive adoption of the internet is closely related to the considerable use of other mechanisms of supply chain integration, namely information sharing and system coupling. This result suggests that virtual integration is one of the different solutions used by these companies to collaborate and integrate processes across the company boundaries. In contrast, firms that use the internet only in limited areas are doing so mostly to increase the effectiveness of information exchange along the supply chain.

To summarise, we can draw two main conclusions. First, internet adoption generally follows incremental strategies that go from a limited to a wider use of e-business tools along the supply chain, starting from external processes and subsequently integrating internal ones. Second, extensive use of the internet along the supply chain is expected to be coupled mainly with close collaboration relationships, while limited adoption is often simply related to information sharing effectiveness.

Based on these results, some managerial implications can also be drawn.

When facing decisions regarding the adoption of internet tools within their supply chain processes, companies should consider the overall e-business strategy that is more suitable to their peculiar processes, together with a pattern of implementation. This is especially important for those small companies that cannot invest a large amount of money at one single moment. While integrated e-business strategies – up and downstream – seem to pay off considerably, this is not the best strategy for every company. Managers need to carefully consider the coherence between the internet tools to adopt and choices in terms of integration with customers and suppliers. The internet can support and facilitate information sharing, both in collaborative or in market-type relationships, or can be used to support closer integration (system coupling) with the partners.

The study suggests that future research efforts should be directed towards a deeper analysis of the types of relationship that can be supported by the different e-business strategies, in order to understand which benefits can be drawn by internet-based

solutions in each case. Related to this, further research should also quantify the impact of e-business on supply chain performance, in order to provide an objective measure of its highly proclaimed benefits. Finally, the evolutionary path of e-business adopters is definitely worth studying, in order to understand if there are preferred steps or, instead, different paths can be followed. Only longitudinal evidence will support this research question.

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Appendix. Extract from the IMSS III questionnaire

T3. Please indicate to what extent do you use internet to integrate the activities of the following processes along the supply chain ().

SC5. How do you coordinate planning decisions and flow of goods? ().

Degree of use None				High	Relative payoff None				High		Expected use within one year None				High
1	2	3	4	5	1	2	3	4	5	Procurement of standard parts	1	2	3	4	5
1	2	3	4	5	1	2	3	4	5	Procurement of strategic parts	1	2	3	4	5
1	2	3	4	5	1	2	3	4	5	Inventory management	1	2	3	4	5
1	2	3	4	5	1	2	3	4	5	Production planning and scheduling	1	2	3	4	5
1	2	3	4	5	1	2	3	4	5	Transportation planning	1	2	3	4	5
1	2	3	4	5	1	2	3	4	5	Order processing and tracking	1	2	3	4	5
1	2	3	4	5	1	2	3	4	5	Sales	1	2	3	4	5
1	2	3	4	5	1	2	3	4	5	Customer service and support (CRM)	1	2	3	4	5

Table AI.
T3

	Level of adoption With your suppliers None				High	With your customers None				High
Share information about the inventory levels	1	2	3	4	5	1	2	3	4	5
Share information about production planning decisions and demand forecast	1	2	3	4	5	1	2	3	4	5
Co-location of plants	1	2	3	4	5	1	2	3	4	5
Use of standard packages and containers	1	2	3	4	5					
Agreements on delivery frequency	1	2	3	4	5					
Use of Kanban systems to deliver your products						1	2	3	4	5
Supply your customer through consignment stock and/or vendor managed inventories						1	2	3	4	5
Use of Kanban systems to acquire materials	1	2	3	4	5					
Require your supplier to manage or hold inventories of materials at your own site	1	2	3	4	5					

Table AII.
SC5