Evolutionary patterns in e-business strategy

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Abstract

Purpose – In 2003 the authors investigated the level of adoption of e-business by manufacturing firms in Europe. Four company strategies were identified based on different extents of adoption of internet-based tools for interaction with customers and/or suppliers. The purpose of this paper is to replicate, those analyses using the new release of the International Manufacturing Strategy Survey (IMSS) IV. These new results are compared with previous ones in order to determine whether modeling previously described in the literature remains valid.

Design/methodology/approach – Data collected in Europe through IMSS III and IV are used. In particular, companies are clustered according to e-business practices adopted in supply chain management (SCM) and the degree of adoption of e-business between the two editions of the research is compared. A longitudinal analysis is also conducted using data from companies participating in both editions of the survey.

Findings – It is shown that the fundamental aspects of the modeling approach earlier proposed in the literature remain valid, with a higher average level of adoption of e-business tools in the more recent edition of the study. However, the four-cluster model is shown to be no longer valid. In the more recent dataset, three clusters emerge. They are characterized by different levels of adoption of e-business, balanced between e-commerce and e-procurement. The longitudinal analysis shows that the firms participating in both editions of the research have changed their strategy, coherently to what the overall sample does.

Research limitations/implications – This paper is focused on the assembly industry and only part of the sample is strictly longitudinal. Further research is needed to relate e-business strategy with performance and to distinguish among the various tools available.

Practical implications – This paper also shows that the adoption of e-business is increasing among small and medium firms, even if the practices adopted by any individual company remain limited. Results show that a cautious adoption is preferable to more radical implementation, since some firms have actually reduced their initial efforts to adopt e-business.

Originality/value – The literature currently lacks extensive, longitudinal studies on e-business strategies in SCM. The paper shows how the concept has rapidly evolved recently, and it modifies models that are proposed only a few years ago in the face of new data.

Keywords Supply chain management, Internet, Electronic commerce

Paper type Research paper

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Introduction

The operations management literature has devoted significant attention to supply chain management (SCM) in the last decade. Within this literature, many authors dealt

with the topic of supply chain integration. Generally speaking, "supply chain integration" refers to the efforts put in place by firms from a broad variety of industries to improve their performance, and the performance of firms that comprise the entire network to which they belong, by interacting more closely and even collaborating with customers, suppliers, partners, and third parties in general.

In this field of research, significant attention has been given to the role of information and communication technologies (ICT) in supply chain integration. Following the publication of the seminal works on this topic (Malone *et al.*, 1987), ICT importance has proven to be significant, and several contributions to the literature have discussed their impact on managerial practices and operational performance. With the rise of the internet in the last ten years, a large number of publications and studies have sought to establish the importance of this technology in SCM. Even though several publications and success cases studies have been presented in the literature, relatively few studies examine the development of the internet phenomenon in SCM over time.

Cagliano *et al.* (2003) analyzed the adoption of internet technologies in supply chain processes by examining a large sample of European manufacturing firms that participated in the third edition of the International Manufacturing Strategy Survey (IMSS III). Two years later, the article was updated (Cagliano *et al.*, 2005) on the basis of secondary sources; the main elements seemed to remain valid, but the analysis was not based on newer IMSS data.

Now that the fourth edition of the IMSS is available, the present paper aims to understand if the modeling (Cagliano *et al.*, 2003) proposed earlier in the literature remains valid and to assess whether there are significant patterns that emerge by comparing the two editions of the survey.

The remainder of the paper is structured as follows: the next section will provide a review of the current literature on supply chain integration and ICT, then the research goals and methodology will be presented and the findings from the empirical research will be described. In the final section, these results will be discussed in detail and suggestions for future research development will be presented.

Literature review

Supply chain integration

Supply chain integration can be seen as the natural evolution of approaches such as the customer-supplier partnership (Lamming, 1993), i.e. the process of moving from an adversarial and arm's-length relationship to a more collaborative one. Typically, the goal is to create and coordinate manufacturing processes seamlessly across the supply chain in a manner that most competitors cannot easily match (Anderson and Katz, 1998; Lummus *et al.*, 1998; Frohlich and Westbrook, 2001). This focus shifts attention towards supply chain-based competition (Ronchi, 2003). Moreover, the general trend of decentralizing value-adding activities by outsourcing and developing virtual enterprises has increased the need for integration, especially through ICT (Gunasekaran and Ngai, 2004).

Many studies show that a higher level of integration leads to better operational performance (Frohlich and Westbrook, 2001; Cagliano *et al.*, 2003; Devaraj *et al.*, 2007; Sanders, 2007; Harland *et al.*, 2007; Zhou and Benton, 2007), which suggests that all firms should invest in this direction. Moreover, the effort of integrating with customers

and suppliers should always be supported by a strategic and holistic view of the supply chain (Power, 2005).

The topic of integration is particularly challenging since it takes into account several issues. For example, contracts are considered a useful tool for aligning the objectives of the various actors (Cachon, 2003). However, adopting a coordination contract can hardly be considered on its own as a form of integration; instead, it is only one part of a deeper collaboration that involves information sharing, physical logistics, and joint decision making (Power, 2005). Competences should be taken into account as well (Rosenzweig and Roth, 2007), and organizational changes should be developed accordingly (Stank *et al.*, 2001; Vickery *et al.*, 2003; Sanders, 2007).

The areas where integration can generally be realized are research and development, and production and logistics (de Toni and Nassimbeni, 1999). Significant attention has recently been devoted to the latter area, which is also the focus of this paper.

In the area of production and logistics, researchers have identified two complementary ways in which supply chain integration can be applied (Frohlich and Westbrook, 2001; Cagliano *et al.*, 2006): information sharing and system coupling. The former concerns the exchange of information about such aspects as market demand, inventories, production plans, and delivery dates. Lee *et al.* (1997) provide many examples of information sharing as an effective instrument to face the bullwhip effect (Forrester, 1961).

The second type of integration, system coupling, involves coordinating physical activities, through mechanisms such as vendor-managed inventory, collaborative planning forecasting and replenishment, or just-in-time (JIT) purchasing (JIT or Kanban), in order to obtain a smooth material flow and seamless supply chain (Childerhouse and Towill, 2003; Disney and Towill, 2003). By adopting such mechanisms, an integrated supply chain offers firms the opportunity to compete on the basis of speed and flexibility, while at the same time maintaining minimum levels of inventory in the chain (Power, 2005; Devaraj *et al.*, 2007).

The internet in SCM

Inside the supply chain integration sphere, significant importance has been given to the subject of information integration using electronic tools. The adoption of electronic communication channels between firms has been a relevant issue for several years (Malone *et al.*, 1987), and the literature contains several contributions on the role of ICT in SCM from different perspectives (Gunasekaran and Ngai, 2004; Power and Singh, 2007). Some studies have focused on the objectives that drive companies to invest in these technologies (Webster, 1995; Ho, 1996, Williams, 1997; Maloni and Benton, 1997). Other authors have focused on the possibility of building "virtual supply chains," thus having companies capable of changing the network structure and the echelons of the chains (Webster, 1995; Voss, 1996). Other contributions considered the problems that arise in integrating ICT into SCM from both the technological (Pawar and Driva, 2000) and organizational (Ho, 1996) points of view.

In the last ten years, however, much attention has been paid to the role of internet-based tools in increasing the sharing of information in the supply chain, and this is often referred to as e-business. Several authors have debated the importance of these tools in business-to-business transactions (Evans and Wurster, 1999; Skjoett-Larsen, 2000; Kehoe and Boughton, 2001; Ronchi, 2003, Croom, 2005;

Kouvelis *et al.*, 2006, Cagliano *et al.*, 2003; Devaraj *et al.*, 2007; Sanders, 2007; Harland *et al.*, 2007; Zhou and Benton, 2007), with the aim of understanding the e-business phenomenon specifically within SCM.

In particular, several authors provide evidence that the internet allows companies to manage supply chain activities better. Transaction costs are reduced, which allows for the development of new relationships between companies (Croom, 2001; Ronchi, 2003; Barratt and Oke, 2007). In addition, the bullwhip effect can be reduced, or at least controlled better (Elliman and Orange, 2000; Emiliani, 2000; Olhager and Sellin, 2003). Purchasing performance can be improved (McIvor *et al.*, 2000), and the flow of information along the supply chain can be easily transferred, which helps companies to be more responsive (Naylor *et al.*, 1999; Feeny, 2001; Murillo, 2001; Aviv, 2001, Kulp *et al.*, 2004; Devaraj *et al.*, 2007).

Other authors have focused on the different processes that can be improved by the use of the internet; thus, we have e-commerce when the internet supports sales and distribution (Brynjolfsson and Smith, 2000; Lancioni *et al.*, 2000; Frohlich and Westbrook, 2002; Zhu and Kraemer, 2002; Zhu *et al.*, 2004; Barua *et al.*, 2004; Johnson *et al.*, 2007; Devaraj *et al.*, 2007); e-procurement and e-sourcing, when we consider procurement, order fulfillment, and sourcing activities (de Boer *et al.*, 2002; Zhu and Kraemer, 2002; Poirier and Quinn, 2003; Barua *et al.*, 2004; Devaraj *et al.*, 2007); and e-collaboration, when we consider capacity planning, demand forecasting, and inventory management (Lee and Whang, 2001; Frohlich and Westbrook, 2002; Hill and Scudder, 2002; Poirier and Quinn, 2003; Barua *et al.*, 2004; Devaraj *et al.*, 2007). Several tools have been developed in order to support these new processes (e.g. auctions, marketplaces, catalogues, etc.), which accommodates different needs and objectives.

E-business strategy has been conceptualized to highlight the important role that the internet plays in defining the competitive advantage of companies. In the specific context of SCM, an e-business strategy refers to how internet tools are used to achieve the integration a given company seeks to introduce. Numerous studies examine the impact of e-business strategy on operational performance and organizational structure (Croom, 2001; Sampler, 1998; Ronchi, 2003; Bagchi and Skjoett-Larsen, 2003; Power, 2005). Research on this issue has produced inconsistent results, claiming that, as Sanders (2007) suggests, "a productivity paradox exists" (Lim *et al.*, 2004; Sriram and Stump, 2004). Several explanations have been proposed for the contradictory results obtained in research on the adoption of internet technologies in the supply chain. Some authors claim that the impact of ICT technologies is not directly related to performance, since they enable only particular forms of cooperation along the supply chain that have a positive effect on operations (Sanders, 2007; Devaraj *et al.*, 2007). Moreover, some research suggests that companies are unable to promptly evaluate benefits of internet technologies, since their competences and organizational structures need time to adapt to the new tools and processes (Power and Singh, 2007), and since there is a time lag between information technology (IT) investment and its impact on performance (Devaraj and Kohli, 2003). Some authors have also concluded that the impact of ICT technologies changes according to the presence of specific enablers, such as cross-functional teams (Robey *et al.*, 2002) and purchasing teams (Ellram and Pearson, 1993; Giunipero and Vogt, 1997; Johnson *et al.*, 2007). In addition, some authors have examined management's failure to exploit the full potential of ICT (Dos Santos and Sussman, 2000), as well as the impact of ineffective implementation of ICT

(Stratopoulos and Dehning, 2000). All these considerations may explain why some companies decide to change the degree of ICT adoption over time.

The spread of the internet as a supply chain integration mean

Even if the literature has contributed to the debate on the role of the internet in SCM, relatively few studies have addressed the spread of internet-based tools in SCM and supply chain integration (Bagchi *et al.*, 2005). According to Cagliano *et al.* (2005), the literature seems to focus primarily on specific internet-based tools (e.g. auctions, catalogues, and e-commerce) applied in specific contexts.

Examination of some recent industry outlooks shows that transactions that rely on these instruments are increasing today (Bertelè *et al.*, 2005; Forrester Research, 2007; Lee and Barua, 1999; Boyer and Olson, 2002; Zhu and Kraemer, 2002; Barua *et al.*, 2004). More specifically, the use of internet-based transactions seems to be growing faster than the use of traditional electronic systems such as electronic data interchange. Some studies have therefore tried to examine what companies are doing and to highlight the existence of relevant gaps between the scientific literature and company practices (Fawcett and Magnan, 2002). McAdam and McCormark (2001) claim that integration in the supply chain is frequently limited to dyadic relationships (i.e. customer-supplier interface). Kemppaien and Vepsalainen (2003) show that Finnish companies adopt information sharing tools only to a limited extent, while Olhager and Selldin (2003) provide evidence that Swedish companies show a focused application of IT tools in specific supply chain activities. Matapoulos *et al.* (2007) show that the impact of internet-based tools on supply chains changes significantly among different industrial sectors.

Among all these contributions, Cagliano *et al.* (2003) provide important evidence based on the IMSS III project, developed in 2001 and which seeks to analyze how companies use the internet to design their supply chains. In this work, different patterns of adoption of e-business tools were taken into account in order to identify which strategies were adopted and their impact on supply chain collaboration. Four e-business strategies were identified: traditionals (i.e. no use of e-business), e-sellers (use of e-commerce only), e-purchasers (use of e-procurement only), and e-integrators (joint use of e-commerce, e-procurement, and e-operations). This work was based on data collected during 2001, when the internet phenomenon reached the "peak of inflated expectations" of the well-known Gartner hype cycle (www.gartner.com). Immediately afterwards, the fall of the Nasdaq and of many internet-based firms led to the "trough of disillusionment" (Cagliano *et al.*, 2005). Since then, the "slope of enlightenment" began, making the adoption of internet-based tools proceed more slowly but also more confidently. Thus, the implementation of internet technologies may have changed in the last few years, and the distribution of e-business strategies may differ substantially. Moreover, as some authors claim, some companies are dissatisfied with the performance of e-business technologies (Poirier and Quinn, 2003; Zhu and Kraemer, 2002). This is due to the lack of competencies that companies had when they first invested in internet technologies and to specific process improvement programs needed to adapt the organization to the new tools. These elements reduce the positive impact of internet technologies on processes and require additional time in order to provide results (Stank *et al.*, 2001). This has forced companies to change their approach towards e-business once the cost and benefits trade-off of internet applications became clear (Sanders, 2007; Devaraj *et al.*, 2007).

Apart from this research, few studies have examined whether companies have changed their e-business strategy over time (Harland *et al.*, 2007).

Research goals

The goal of this paper is to analyze the diffusion of e-business over time in order to evaluate how companies are investing in internet-based tools to manage their supply chain. Specifically, we aim to replicate the analysis performed on the IMSS III data collected in 2001 (Cagliano *et al.*, 2003), in order to investigate whether the pattern of adoption of e-business tools has changed over the subsequent four years. Replication is a fundamental part of the scientific process (see Frohlich and Dixon, 2001, for a review): theory-building must be followed by rounds of verification and elaboration (Flynn *et al.*, 1990). In particular, a new and fast evolving issue, such as e-business, needs to be frequently monitored both to test the robustness of initial findings and to identify evolutionary trends.

Several authors claim that the number of supply chain transactions involving internet-based tools is increasing (Bertelè *et al.*, 2005; Forrester Research, 2007; Lee and Barua, 1999; Boyer and Olson, 2002; Zhu and Kraemer, 2002; Barua *et al.*, 2004). Much of the literature assumed that following the "peak of inflated expectation," the adoption of information technologies would proceed confidently (Cagliano *et al.*, 2005), even if it can differ between countries (Kemppaien and Vepsalainen, 2003; Olhager and Sellin, 2003) and industrial sectors (Matapoulos *et al.*, 2007). However, the literature provides limited evidence of what companies are doing, and empirical studies are needed to test whether the adoption of ICT in the supply chain is truly increasing. For all these reasons, we sought to test the following research proposition:

RP1. The level of adoption of internet-based tools within supply chain relationships has increased over time

The literature suggests that the impact of the different tools depends on several contingent factors, such as the existence of specific kinds of teams (Giunipero and Vogt, 1997; Robey *et al.*, 2002; Johnson *et al.*, 2007), the possibility of developing specific forms of cooperation along the supply chain (Sanders, 2007; Devaraj *et al.*, 2007), and a company's competencies and organizational structures (Power and Singh, 2007). It follows that different companies will invest differently in the use of internet technologies within the supply chain.

Cagliano *et al.* (2003) provided evidence that companies had invested heterogeneously differently in e-business tools. Based on IMSS III data, four e-business strategies were identified: traditionals (i.e. no use of e-business), e-sellers (use of e-commerce only), e-purchasers (use of e-procurement only), and e-integrators (joint use of e-commerce, e-procurement, and e-operations). Two years later, the paper was updated (Cagliano *et al.*, 2005) on the basis of secondary sources, but no new IMSS data were available. Consequently, research replication is particularly important in this case, since constructs need to be verified over time and relationships need to be tested on different samples (Frohlich and Dixon, 2001). For this reason we sought to test the following research proposition:

RP2. The four e-business strategies, namely traditionals, e-sellers, e-purchasers, and e-integrators, are confirmed using more recent data.

Even if alternative strategies remain stable over time, some companies may have changed their own e-business strategy; in other words, they may have moved from one cluster to another. However, Cagliano *et al.* (2003) showed that firms, at that time, were planning to increase their efforts towards e-business, but without changing their strategy. This means that e-sellers declared that they were going to increase the adoption of internet tools primarily with customers (e-commerce); e-purchasers were increasing the use of e-procurement; and e-integrators, for their part, were going to continue to utilize e-business intensively with both customers and suppliers. Using more recent IMSS data, we could test whether the strategies and efforts that companies adopted remain stable over time. For these reasons, we wished to test the following research proposition:

RP3. Firms are adopting the same e-business strategy over time.

Methodology

Sample

In order to investigate the three propositions, we collected data from the fourth edition of the IMSS IV, a research project carried out by a global network of investigators in 2005, and we compared these data with the results collected in 2001 (IMSS III). The IMSS project, originally launched by the London Business School and Chalmers University of Technology, studies manufacturing and supply chain strategies within the assembly industry (ISIC 28-35 codes). It uses a detailed questionnaire that local research groups administer simultaneously in many countries. The responses are gathered in a single global database (Lindberg *et al.*, 1998).

In order to gain a longitudinal perspective, we compare data collected from two subsequent releases of the same research project, which are very similar, despite some differences among single respondents. We consider this choice acceptable, since our main goal is not to study individual firms, but rather to compare two similar samples in the same industry and economic areas. Nevertheless, we can investigate also the same companies over time (strict longitudinality), since a sub-set of firms participated in both editions of the survey.

Consistent with Cagliano *et al.* (2003), research propositions have been tested on the basis of the European sub-samples of IMSS III and IV, which consist, respectively, of 338 and 423 firms from eight and 13 countries, with an average response rate of 34 and 14 percent. The usable sample included 276 and 357 firms, respectively, which provided enough information for the purposes of this study. The following tables describe the distribution of the sample in terms of country ("a" tables), industry ("b" tables), and company size ("c" tables). Table I (a)-(c) refers to the IMSS III (2001) sample, while Table II (a)-(c) uses the new IMSS IV (2005) data. The industry type is identified through the ISIC code (Table III). Because, the ISIC code has recently been revised, we had to recode the new sample, which was originally encoded with the old ISIC classification (revision 2), with the new ISIC classification scheme (revision 3.1) in order to make the two samples comparable.

The longitudinal sub-sample consists of 47 firms belonging to both the IMSS III and IV samples. They are described in terms of country, industry, and company size in Table IV.

	n	%
(a) Country		
Denmark	34	12.32
Germany	28	10.14
Hungary	53	19.20
Ireland	27	9.78
Italy	55	19.93
Norway	20	7.25
Spain	17	6.16
UK	42	15.22
(b) ISIC		
28	77	27.9
29-30	75	27.2
31-32	73	26.4
33	21	7.6
34-35	30	10.9
(c) Size [a]		
Small	135	48.9
Medium	56	20.3
Large	85	30.8
Total	276	100.0

Note: [a]Small – less than 250 employees; medium – 251-500 employees; large – over 501 employees

Table I.
Distribution of firms in the IMSS III sample in terms of country, industry, and company size

Measures

In order to replicate the analysis of the previous work, we had to build the same constructs with the new data, while also checking for their validity and reliability. We used principal component analysis with varimax rotation to obtain the measures for e-business adoption.

We used exploratory factor analysis since our questions related to e-business are not identical to those used in the previous release, given that the concept has evolved in recent years. In particular, the questions related to the use of the internet in supporting internal operations of the company (i.e. production planning and scheduling, and inventory management) were not included, since they are no longer considered part of the e-business concept even though they are often included in ERP suites. Questions related to the different internet-based tools used to interact with customers and suppliers were used, with responses linked to a Likert-like scale of 1-5. The factor analysis highlighted the existence of a single construct referring to each side of supply chain relationships, which have been named e-commerce and e-procurement (Table V). In the e-commerce factor, the item "collaboration support services" had a low value of factor loading, so we eliminated it from subsequent analysis. The high values of Cronbach's alpha confirm the reliability of these constructs (DeVellis, 1991; Nunnally, 1994).

When dealing with survey data, common method bias (CMB) can affect statistical results. Podsakoff *et al.* (2003) suggest different approaches to check for CMB. We assessed the severity of method variance by conducting a confirmatory factor analysis on competing models that increase in complexity (Podsakoff *et al.*, 2003; Korsgaard and Roberson, 1995). If method variance is a significant problem, a simple model (e.g. a single-factor model) should fit the data as well as a more complex model

	n	%
(a) Country		
Belgium	28	7.84
Denmark	29	8.12
Estonia	18	5.04
Germany	14	3.92
Greece	7	1.96
Hungary	53	14.85
Ireland	12	3.36
Italy	38	10.64
Norway	16	4.48
Portugal	9	2.52
Sweden	66	18.49
The Netherlands	54	15.13
UK	13	3.64
(b) ISIC		
28	131	36.8
29-30	81	22.8
31-32	79	22.2
33	19	5.3
34-35	46	12.9
Missing	1	
(c) Size [a]		
Small	197	55.2
Medium	90	25.2
Large	70	19.6
Total	357	100.0

Note: [a]Small – less than 250 employees; medium – 251-500 employees; large – over 501 employees

Table II. Distribution of firms in IMSS IV sample in terms of country, industry, and company size

ISIC (revision 3.1) code	Industry description
28	Manufacture of fabricated metal products, except machinery, and equipment
29	Manufacture of machinery and equipment not classified elsewhere
30	Manufacture of office, accounting, and computing machinery
31	Manufacture of electrical machinery and apparatus not classified elsewhere
32	Manufacture of radio, television, and communication equipment and apparatus
33	Manufacture of medical, precision, and optical instruments, watches and clocks
34	Manufacture of motor vehicles, trailers, and semi-trailers
35	Manufacture of other transport equipment

Table III. Table of correspondence between ISIC code revision 3.1 and industry description

(in this case, a two-factor model). The hypothesized model with two factors yielded a better fit of the data than the simple model: CFI is 0.789 and RMSEA is 0.274 on IMSS III data; CFI is 0.74 and RMSEA is 0.144 on IMSS IV data. Furthermore, the improved fit of the two-factor model over the simple model was statistically significant: on IMSS III data, the change in χ^2 is 101.90 and the change in df is 1 ($p < 0.01$); on IMSS IV data, the change in χ^2 is 225.36 and the change in df is 1 ($p < 0.01$). Thus, CMB did not appear to be a problem in our analysis.

	n	%
(a) Country		
Denmark	4	8.5
Germany	7	14.9
Hungary	9	19.2
Ireland	8	17.0
Italy	11	23.4
Norway	1	2.1
UK	7	14.9
(b) ISIC		
28	12	25.5
29-30	12	25.5
31-32	17	36.2
33	5	10.7
34-35	1	2.1
(c) Size [a]		
Small	15	31.9
Medium	6	12.8
Large	26	55.3
Total	47	100.0

Note: [a]Small – less than 250 employees; medium – 251-500 employee; large – over 501 employees

Table IV.
Distribution of firms of the longitudinal IMSS III and IV samples in terms of country, industry, and company size

Item name	E-business with suppliers E-procurement	Mean	E-business with customers E-commerce	Mean
Scouting/pre-qualify	0.699	2.610	0.569	1.720
Auctions	0.535	1.604	0.755	2.862
Rfx	0.739	2.847	0.850	2.488
Data analysis	0.772	2.527	0.594	2.680
Access to catalogues	0.664	3.017	0.749	2.883
Order management and tracking	0.714	2.827	0.827	2.402
Content and knowledge management	0.749	2.317	0.810	2.465
Collaboration support services	0.771	2.325	0.300	2.767
Eigen value	4.022		3.960	
Total variance explained (percent)	50.276		49.503	
Cronbach's alpha	0.856		0.859[a]	
Factor mean	2.511		2.506[a]	

Note: [a]Calculated without the item "Collaboration support service"

Table V.
Factor analysis of e-business practices with suppliers and customers

Cluster building

The original clusters of e-business strategies were identified through a two-step cluster analysis, in order to identify the most appropriate number of clusters first, and then assign each firm to the more appropriate cluster (Cagliano *et al.*, 2003). The resulting four clusters (traditionals, e-sellers, e-purchasers, and e-integrators) were originally based on three variables (e-procurement, e-operations, and e-commerce). Since we eliminated the e-operations construct, we used only the e-procurement and e-commerce

clusters. We therefore performed the same two-step cluster analysis on the IMSS III sample using only e-procurement and e-operations, and we obtained the same four clusters without the e-operations variable. As in our previous work (Cagliano *et al.*, 2003), we used first a hierarchical cluster analysis with the Ward method and squared Euclidean distance to identify the natural number of clusters. Subsequently, we assigned each firm to a cluster using the *K*-means algorithm (Ketchen and Shook, 1996). We used the same method to cluster the IMSS IV sample, on the basis of the two constructs of e-procurement and e-operations.

In Cagliano *et al.* (2003), the relationship between e-business strategy and contingent factors (industry, company size, and position in the supply chain) was also tested, and this showed that only industry significantly affected the distribution of the firms among the four clusters. However, we tested this relationship with IMSS IV data, but found no significant effect. This means that contingent factors such as industry, company size, and position in the supply chain do not affect the choice of e-business strategy that a firm adopts. Detailed data on this issue are not presented because of space limitations.

Longitudinal analysis

As described above, we also tested our research propositions on a sub-set of firms that participated in both editions of the research, thus allowing us to verify whether emerging trends and strategies are implemented by individual firms. First, we tested whether the sub-sample is representative of the entire population. We assessed this by comparing levels of adoption of e-procurement and e-commerce, and by comparing the trends in the sub-sample with those of the overall sample. The results show aligned values in e-business adoption and a similar trend of increased e-business use between the sub-set of firms and the entire population, which suggests that the sub-sample is representative of the entire population.

Next, we highlighted general patterns and strategies as a given firm moved from the old cluster in IMSS III to a new cluster in IMSS IV. To evaluate the robustness of these trends, we considered e-commerce and e-procurement adoption as the two axes of a Cartesian plane. In this plane, a strategy can be defined as the path between the starting and ending points of a firm. In our case, for each firm in the sub-sample, we had a starting point defined by the IMSS III coordinates, and an ending point defined by IMSS IV coordinates. In this way we broke down every strategy into the two components: the e-commerce and e-procurement differences (Figure 1). The principal axis arrows show the sign of these differences. In other words, a horizontal movement to the right stands for a positive difference in e-procurement and consequently an increase in its adoption; in contrast, a vertical movement upward represents a positive difference in e-commerce, and consequently an increase in its adoption. After calculating the e-procurement and e-commerce differences for each case, we finally evaluated the statistical significance of a firm's movements (i.e. changes in strategies) based on the original cluster to which they belonged in IMSS III.

Results

E-business adoption

Through comparison of the means of the e-business constructs (factors) between IMSS III and IV releases, we notice a slight increase: e-commerce has moved from 1.94 to 2.51,

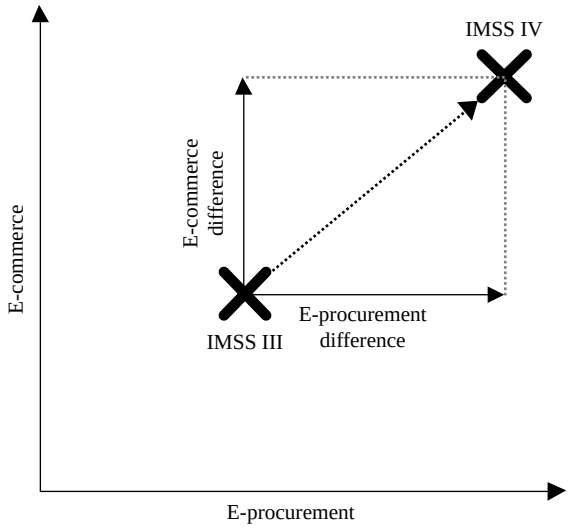


Figure 1.
Example of e-business strategy with positive differences in e-procurement and e-commerce adoption

and e-procurement from 1.90 to 2.51. The ANOVA in Table VI shows that these differences are significant ($p < 0.001$). Therefore, we can conclude that *RP1* is confirmed by the data.

In absolute terms, the average adoption of e-business in general (i.e. both e-commerce and e-procurement) remains low, confirming what industry outlooks have already highlighted. After the initial enthusiasm of the new-economy boom, the subsequent "trough of disillusionment" (Gartner Group) has cooled both expectations and investment. This may be related to the difficulty in perceiving the benefits of such investments (see "Literature review" section). However, our data show that a slight increase in adoption has actually taken place, confirming what other recent research has shown (Bertelè *et al.*, 2005; Forrester Research, 2007). To use again Gartner's terminology, firms are now slowly climbing the "slope of enlightenment"; in other words, they are adopting e-business solutions through gradual and focused investment, opting for an incremental approach rather than radically innovating their business processes. Clearly, these are average values: they describe an ensemble of firms with very different levels of adoption, ranging from no use of any internet-based tool at all, to intensive and pervasive adoption of all available tools. Although considering the average values provides a snapshot of the sample as a whole and is an interesting picture of the general situation, it is much too aggregate to aid in the investigation of different patterns and strategies within the e-business paradigm. In particular, the average values are nearly identical for both e-commerce and e-procurement, but this is insufficient evidence to conclude that they are adopted

Table VI.
ANOVA of the adoption of e-business constructs between IMSS III and IV

	IMSS III	IMSS IV	ANOVA sig.
E-commerce	1.903	2.509	0.000
E-procurement	1.944	2.506	0.000

together. Indeed, previous studies (Cagliano *et al.*, 2003) showed that firms often adopt internet-based tools either for e-commerce or e-procurement, but not both simultaneously, even though the two surveys measure similar average values for both domains.

E-business strategies

Table VII shows the distribution of the IMSS III and IV samples in the clusters, and the related cluster centers.

First of all, it can be noted that the new sample does not cluster into four groups as the old one did. Rather, it clusters into only three groups. More precisely, there are no more mono-directional strategies, i.e. e-purchasers and e-sellers no longer exist. On the contrary, the three clusters emerging from IMSS IV data are characterized by the simultaneous adoption of both e-commerce and e-procurement, at three different levels. We also verified that even if four clusters are imposed, the results are significantly different compared to the clusters emerging from IMSS III: the four clusters identified are still characterized by the simultaneous adoption of both strategies at different levels of adoption.

The low adopters cluster is very similar to the old traditionals group, in that it comprises companies with very low values of both e-commerce and e-procurement. This group accounts for 27 percent of the whole sample. The partial adopters cluster is formed by firms with intermediate levels of adoption of both e-commerce and e-procurement, which is a strategy that we did not find in the previous release of the survey. This group accounts for 33 percent of the whole sample. Finally, the high adopters cluster contains firms with extremely high values of e-business adoption with both customers and suppliers. This is similar to the e-integrators group of the previous release. It should be noted, however, that this cluster accounts for 40 percent of the total sample, while in the past it was only 7 percent. This explains why cluster centers have slightly lower values in the new release, since this group includes a quite broad range of firms, not just "extreme" adopters.

The first result that emerges from the clustering is that the four strategies identified four years ago are not confirmed by the new data, leading us to reject *RP2*. This finding is supported by the dispersion of firms in the two samples (Figure 2). It can be seen clearly that firms have moved towards the diagonal, i.e. towards similar values of e-commerce and e-procurement. At the same time, the number of firms that do not adopt any form of e-business (score 1 on both dimensions) is much lower in the new sample than in the old one, although a high number of low adopters remain. At the same time, the number of firms with extremely high levels of adoption (score 5 on both dimensions) is very limited in both samples. Comparing the two samples, it is clear that the highest concentration of firms has moved from the bottom left corner of the table to the centre, indicating a low to medium adoption of e-business, as previously inferred from the average values. This result again confirms *RP1*.

This result is interesting, since it casts new light on the average increase in e-business adoption that we have discussed so far. Despite the fact that during the intervening years firms have only marginally increased their use of internet-based tools to manage supply chain relationships, they have clearly changed their e-business strategies, particularly those companies originally choosing a mono-directional strategy. This result suggests that firms have evolved their strategies more towards a balanced one,

Table VII.
Distribution of the IMSS III and IV samples in the various clusters

Cluster	IMSS III					IMSS IV			
	1	2	3	4	ANOVA sig.	A	B	C	ANOVA sig.
E-commerce	1.33	3.10	1.73	4.25	0.000	1.70	2.71	3.37	0.000
Pairwise difference	(2; 3; 4)	(1; 3; 4)	(1; 2; 4)	(1; 2; 3)		(B; C)	(A; C)	(A; B)	
E-procurement	1.32	1.85	3.42	4.14	0.000	1.55	2.64	3.71	0.000
Pairwise difference	(2; 3; 4)	(1; 3; 4)	(1; 2; 4)	(1; 2; 3)		(B; C)	(A; C)	(A; B)	
Number	153	64	39	20		124	150	182	
Percent	55.4	23.2	14.1	7.3		27.2	32.9	39.9	

Notes: Cluster numbering: 1 – traditionals, 2 – e-sellers, 3 – e-purchasers, 4 = e-integrators; A – low adopters, B – partial adopters, C – full adopters; numbers in brackets show significantly different clusters ($p < 0.05$) using the Scheffè method

in order to exploit e-business benefits in all their supply chain relationships. This change in strategy seems to be related to the increased maturity of both firms and internet-based solutions, since today almost no firm adopts either e-commerce or e-procurement alone. Indeed, when companies at first invest in new technologies, they may not be completely aware of what they need in order to fully exploit these technologies, and they also need to adapt their strategy to the contingencies of their particular situation. This change in strategy may also reflect growing maturity of management in making ICT investments (Dos Santos and Sussman, 2000; Stratopoulos and Dehning, 2000) and in implementing appropriate performance measures (Bharadwaj *et al.*, 1999). A possible alternative explanation, which is not currently considered by literature, is that bi-directional strategies may be more effective than "pure" ones.

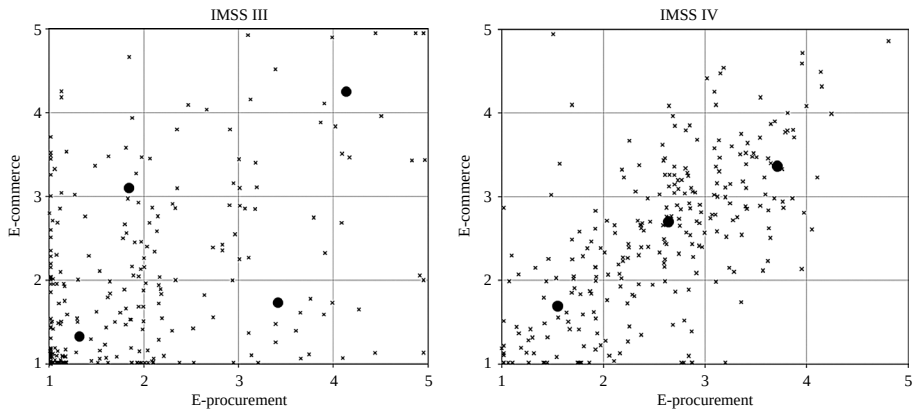
We can, therefore, conclude that the modeling proposed by Cagliano *et al.* (2003) is no longer valid, confirming the perception that e-business is still a rather new and evolving, rather than a fixed, concept.

Evolution of e-business strategies

The 47 strictly longitudinal firms have been analyzed separately to investigate the evolution in their e-business strategies. Figure 3 shows the distribution of the sub-sample in the two editions of the research. Table VIII shows the distribution of the sub-sample in the IMSS III and IV clusters.

Although the sub-sample accounts for a limited portion of the overall sample, the distribution of companies is similar: in IMSS III there is a predominance of traditionals, as in the overall sample, while in IMSS IV firms have clustered along the diagonal and moved towards the centre of the graph (partial adopters). To confirm again that the sub-sample is representative, we can observe that it shows aligned values in e-business adoption and a similar trend of increasing e-business use similar to what is observed with the entire population (Table IX).

In Table VIII, we can observe that the large group of traditionals has taken different evolutionary paths: one-third remained low adopters, while more than half moved to partial adopters, with only two firms becoming full adopters. Although we cannot generalize this result, it seems to confirm the overall trend that many non-adopters or



Note: Larger dots represent cluster centers

Figure 2.
Distribution of firms according to e-commerce and e-procurement in both IMSS III (left) and IMSS IV (right) samples

low adopters of IMSS III have evolved towards an intermediate adoption of e-business with both customers and suppliers.

Firms that initially adopted mono-directional strategies in IMSS III (e-purchasers or e-sellers) have evolved towards a bi-directional adoption of e-business, but by following different paths. Almost half of them are now low adopters, meaning that they have reduced their efforts towards e-business, apparently unsatisfied by the results obtained. A few of them have become partial adopters, thus balancing their efforts in both directions, while one-third have extended their investments to become full adopters. Finally, we have only one firm that in IMSS III was an e-integrator, which in IMSS IV moved back to partial adopters.

To evaluate these findings more analytically, as described in the methodology section, we analyzed for each case the differences between IMSS III and IV levels of

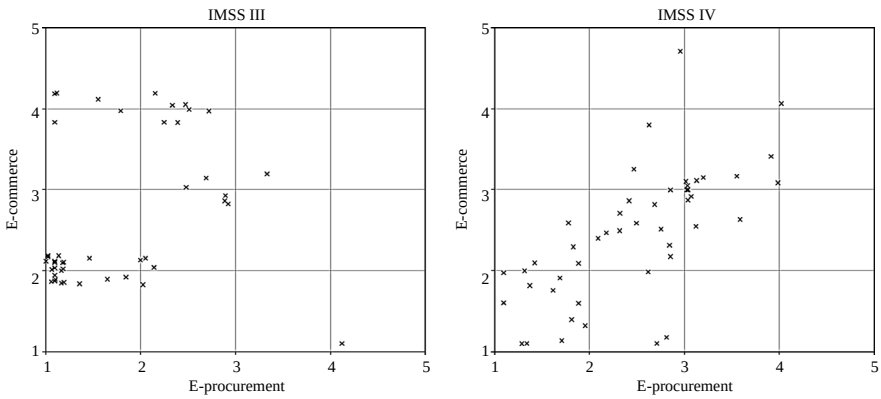


Figure 3.
Distribution of longitudinal firms according to e-commerce and e-procurement in both IMSS III (left) and IMSS IV (right) samples

Cluster IMSS III	Cluster in IMSS IV: Low adopters	Partial adopters	Full adopters	Total
Traditionals	10	16	2	28
E-purchasers	5	3	4	12
E-sellers	3	1	2	6
E-integrators	0	1	0	1
Total	18	21	8	47

Table VIII.
Distribution of the longitudinal sub-sample in the IMSS III and IV clusters

	IMSS III	IMSS IV	ANOVA sig.
Longitudinal sample			
E-commerce	1.689	2.434	0.000
E-procurement	1.950	2.497	0.003
Population			
E-commerce	1.903	2.509	0.000
E-procurement	1.944	2.506	0.000

Table IX.
ANOVA of the adoption of e-business constructs between IMSS III and IV in the longitudinal sample and in the overall population

e-commerce and e-procurement adoption. Next, we compared these values between groups of companies defined according to the original cluster to which they belonged. Because of the single item in the e-integrators cluster, we could not perform statistical analyses on it.

Results in Table X confirm the trends that emerged in the previous analyses on the overall sample. First, the ANOVA significance demonstrates that clusters have moved differently in each dimension (i.e. e-commerce and e-procurement). The means indicate that traditionals have increased by approximately 1 point in 5 of their adoption of both e-commerce and e-procurement. E-sellers followed this trend on e-procurement (1.06), but at the same time decreased their investment in e-commerce (−0.35). Conversely, e-purchasers increased their e-commerce activity slightly less (0.75), but consistently reduced their e-procurement activity (−0.72).

We can therefore conclude that *RP3* is rejected, since single firms have significantly changed their e-business strategies by moving away from mono-directional strategies towards bi-directional ones, and also by changing their level of adoption, generally towards a higher level, but occasionally towards a lower one.

This company-level analysis provides further support for the aggregate results by showing that differences among the two IMSS samples are not significantly related to their different composition, but rather to actual changes in e-business adoption by the component firms, since the strictly longitudinal sub-sample shows similar patterns to the complete samples. Firms are indeed modifying their decisions regarding e-business, confirming that differences among them are related to the level of adoption, a factor that is much more widespread than in the past, rather than to the direction of adoption, which is, by contrast, almost always balanced between the two domains of e-commerce and e-procurement.

In order to further investigate the evolution of e-business strategies in terms of both e-commerce and e-procurement, we have mapped in Table XI the longitudinal

Cluster	Traditionals (1)	E-sellers (2)	E-purchasers (3)	E-integrators (4)	ANOVA sig.
E-commerce difference	1.069	−0.347	0.753	NA	0.006
Pairwise difference	(2)	(1)		NA	
E-procurement difference	1.011	1.062	−0.726	NA	0.000
Pairwise difference	(3)	(3)	(1; 2)	NA	
Number	28	6	12	1	
Percent	59.57	12.77	25.53	2.13	

Note: Numbers in brackets show significantly different clusters ($p < 0.05$) using the Scheffè method

Table X.
Distribution of the e-commerce and e-procurement differences according to IMSS III clusters

E-procurement	E-commerce Decrease	Stable	Increase
Decrease	2	3	3
Stable	4	4	5
Increase	1	4	21

Note: Firms whose values changed no more than ±0.5 are considered stable

Table XI.
Evolution of e-business adoption in the longitudinal sub-sample

sub-sample according to whether their efforts at adoption decreased, increased, or remained stable (differences lower than 0.5 in absolute value). This last analysis allows us to investigate how firms have modified their strategies by considering both e-commerce and e-procurement at the same time. Almost half of the sample increased their efforts in both directions, as seen in the overall distribution, while only two firms have decreased their efforts with both customers and suppliers. However, it is interesting to notice that several firms adopted asymmetric policies by increasing efforts in one direction while remaining stable or even decreasing in the other. This fact explains how the firms balanced their strategies without necessarily increasing their total investment. This result suggests that firms in the last years have adopted a pragmatic and cautious approach to e-business, avoiding extreme investments but trying to exploit benefits along the whole supply chain.

This is further confirmation that firms have indeed changed their e-business strategies, which again calls for rejection of *RP3*. Despite the overall average increase in the level of adoption, which is also observed in the sub-sample, some counter-tendencies can be clearly observed. They may reflect dissatisfaction with the results of initial adoption efforts, but also to the increased maturity achieved through use, which allows one to identify the areas where benefits are greater and thus to focus adoption only where it is worthwhile.

Discussion

Our results confirmed our *RP1*, i.e. that the level of e-business adoption has increased on average, as other sources have already suggested. This is consistent with a growing relevance of the e-business phenomenon, beyond short-term fashion and hype: internet-based tools are spreading, slowly but steadily, across firms in different industries and contexts, reshaping SCM strategies and practices.

However, our results do not confirm the modeling proposed four years ago: although the main constructs of e-business (i.e. e-commerce and e-procurement) remain valid, the four e-business strategies (traditionals, e-purchasers, e-sellers, and e-integrators) are no longer adopted by manufacturing firms in Europe. Instead, three clusters emerged from the new data, namely low, partial, and full adopters. Despite the different level of adoption, all three groups are characterized by a balanced use of e-business with both customers and suppliers (i.e. e-commerce and e-procurement). These results suggest an evolutionary trend in the process of e-business adoption, which shows two distinct features. First is a reduction in the number of low adopters compared to four years ago, though they remain an appreciable proportion of the sample. Second, the integrated adoption of e-business both up- and down-stream has taken the place of partial adoption, reversing the results observed four years ago.

This last result, which is quite unexpected, shows how firms are becoming more mature and conscious about e-business, which in turn is becoming a more consolidated concept than in the past. The fact that most companies have chosen a partial but more pervasive adoption, i.e. both up- and down-stream – supports this conclusion. This contrasts with the alternative hypothesis that could be inferred from the results four years ago. At that time one could argue that mono-directional strategies (e-purchasers and e-sellers) were the first step of an evolutionary path towards e-integration. But if this were the case, there should still be some firms today that adopt such strategies,

particularly among those firms categorized as traditionals four years ago. Instead we find that no firm adopts such a strategy today, and, on average, companies show many different degrees of adoption of both e-commerce and e-procurement at the same time. This leads us to the conclusion that the evolutionary path of adoption, if it exists, now runs along the diagonal of the matrix.

Finally, we investigated the strictly longitudinal sub-sample, i.e. those firms that participated in both editions of the project, thus allowing us to understand the evolution of e-business strategies at the level of individual firms. The results confirm the overall trend towards a slight increase in adoption and a rebalancing between e-commerce and e-procurement. The firms that participated in both editions of the research show an evolutionary trend similar to that of the entire sample, thus confirming results obtained for the whole sample. This means that the differences between the two editions are not likely to be caused by the different composition of the sample. In addition, we observed that some firms even decreased their adoption efforts, either up- or down-stream, along one direction and increased their efforts along another direction. This probably reflects a more conscious and cautious adoption of e-business, which aims at exploiting the real benefits wherever they are easily accessible, without over-investing in one direction.

This last result conflicts with what the same firms declared at the time of IMSS III, when they reported planning an increasing use of e-business in the following years, while continuing in the original direction – in other words, without changing their underlying strategy. It is not really surprising that in the intervening years, some firms changed their mind, especially when one considers how immature they were at the time and how different reality has been compared to the original claims of the "new economy" era. Companies have also been able to verify the effectiveness of their investments only recently, which led some to reshape their strategies. However, these shifts in strategy, and also the reduction in the use of internet-based tools in some cases, further support the claim that e-business is becoming a consolidated concept, adjusting itself in order to become more than an innovative strategy adopted only by the most advanced firms. It is increasingly becoming the way business is conducted every day, by the majority of firms.

Conclusions

We argue that these results are relevant for research, since very few authors have investigated the level and pattern of adoption of e-business strategies on large, longitudinal samples. Moreover, the emerging results, in addition to contrasting with previous findings, shed new light on the evolution of this new and fast-evolving topic.

We also believe that these results are relevant for practitioners, who, thanks to this work, can better understand the current level of diffusion of e-business and its implications for supply chain strategy in general. In particular, our results are interesting for any kind of firm, including small and traditional ones, since they show that the world is changing. In addition, most firms are now slowly adopting e-business, thus paving the way for these companies to keep up with long-term trends in their industry.

Finally, this research opens the door to further investigations. First of all it would be important to relate the various internet-based strategies to firm performance, in order to evaluate the contribution to company results. This would also help in better understanding why companies may have changed their approach towards internet

technologies. Future studies should analyze in more detail the different patterns of e-business adoption observed in this work, especially those situations in which investment is shifted away from certain areas. A detailed analysis of the elements that explain this behavior would help companies better understand how to introduce e-business into their supply chains.

Second, e-commerce and e-procurement are today two very broad concepts: it is definitely important to investigate each of them further in order to understand the different kinds of applications that are adopted, the purposes for which they are adopted, and the results that are obtained.

Third, since the IMSS project is global a comparison with different geographical areas is possible and would be useful for understanding whether different patterns exist in different regions.

Generally speaking, further development of this research would greatly benefit from an in-depth qualitative analysis of some case studies, in order to better understand the details of the adoption of e-business tools. For example, it would be interesting to understand the goals that lead to adoption, the different functionalities that are adopted, the organizational and relationship implications of the adoption, as well as the results achieved. Most of all, a dyadic case study design that investigates the adoption of e-business from both the customer and the supplier perspective would provide a more complete picture of the phenomenon. Our results provide a useful starting point to design further research, since they lay the groundwork for developing these interesting follow-up investigations.

The findings of the paper lead us to possible hypotheses about future corporate behavior. The data we have analyzed provide evidence that companies consider e-business a relevant issue, even if a relatively small number of them are investing significantly in these applications. Previous literature has claimed that this behavior may be due to enabling elements that may enhance the impact of e-business technologies on company performance. This result is consistent with core competence theories that argue that competing companies develop those competencies that prove to be most useful for achieving their goals (Hamel and Prahalad, 1990; Peteraf, 1993; Barratt and Oke, 2007). This suggests that companies that invest now in e-business technologies will develop better competencies and will probably be able to invest more and more effectively in them in the future. Thus, they will be able to improve performances through the use of e-business technologies, while those companies that are now limiting their investments in these technologies will not be able to realize similar benefits. Therefore, we predict that future studies, even if they find a continuum in levels of e-business adoption, will show that the distance between the low adopters and the full adopters increases over time, leading to a "digital divide" paradigm: companies will have to choose whether e-business is a critical element of their strategy or not, and invest accordingly.

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