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ORIGINAL ARTICLE

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Focus of B-to-B e-commerce initiatives and related benefits in manufacturing small- and medium-sized enterprises

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Abstract Empirical research into business-to-business e-commerce issues involving manufacturing small- and medium-sized enterprises (SMEs) is still embryonic. In an attempt to partially fill this gap, this paper presents empirical data from an electronic survey conducted among 96 manufacturing SMEs to investigate e-commerce initiatives and their related benefits. E-commerce initiatives are assessed using a set of 36 business processes that can be conducted electronically. These processes were classified according to their focus: customer (downstream), supplier (upstream) or in-house. The research findings point to four main profiles of manufacturing SMEs with different e-commerce focuses. The first group seems to lack any focus or may still be exploring e-commerce opportunities. The second and third groups are supplier- and customer-focused, respectively. The fourth group consists of the more involved SMEs that have leveraged their e-commerce initiatives with

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both their customers and their suppliers. Results also suggest the existence of a close alignment between e-commerce focus and related benefits.

Keywords B-to-B e-commerce · Business processes · SMEs

1 Introduction

The impact of technology on manufacturing has always been a strategic issue for nations striving for industrial productivity and better corporate performance (Buffa 1984; Wheelwright and Hayes 1985). In the late 1950s many prominent scholars were convinced that manufacturing productivity problems were a thing of the past (Skinner 1987). Since then, however, we have witnessed a proliferation of advanced manufacturing technologies (AMTs) that have boosted firms' capabilities and translated into improved performance for the organizations that adopt them. Recent advances in information and communication technologies (ICTs) are giving manufacturing organizations a new competitive edge (Shaw et al. 1997; Lefebvre et al. 2001). Researchers related the growing impact of ICTs on organizations' performance to the surge in Internet use and the adoption of business-to-business (B-to-B) electronic commerce (Blinder 2000; McAfee 2002). We borrow in this paper the broad definition of e-commerce as stated by Magal et al. (2001:2) "e-commerce is considered as the use of Internet and related technologies to support any activity that is necessary for an organization to function effectively." A recent survey confirmed that, in the United States, manufacturing continues to lead all industry sectors in e-commerce shipments (US Department of Commerce 2002). Some researchers are indicating that large manufacturers have been adopting B-to-B e-commerce, leaving their suppliers, mostly small- and medium-sized enterprises (SMEs) in the manufacturing sector, with little choice but to follow. SMEs, are defined here as firms with fewer than 500 employees, a definition similar to the one used by government agencies such as the US Small Business Administration. SMEs' limited resources make it crucial for them to harness business value in adopting new technologies. It is therefore very important for SMEs' managers to understand the impact of e-commerce on their organizations' performance and competitiveness.

The challenges of adopting e-commerce differ depending on a firm's size (Barua et al. 2001; Curran and Blackburn 2001). To date, however, little empirical research has focused on manufacturing SMEs and the benefits they derive from e-commerce initiatives. In an attempt to partially address this gap, this paper presents results from an exploratory study of the state of B-to-B e-commerce penetration in manufacturing SMEs. The study departs from previous work by proposing a set of 36 business processes that can be performed by electronic means. This set of business processes allows one to assess the breadth and the depth of B-to-B e-commerce initiatives. Finally, the degree of alignment or fit between a typology of e-commerce initiatives and their respective benefits is investigated in the context of manufacturing SMEs.

The paper is structured as follows. In the next section, we will briefly examine some of the relevant literature regarding B-to-B e-commerce and its related benefits. This is followed by a discussion of the methodology (Sect. 3). The results are then presented and discussed in Sect. 4. The last section concludes with some brief remarks and prospects for future research (Sect. 5).

2 Theoretical issues

E-commerce is growing steadily (OECD 2002) and is offering organizations many opportunities to create wealth (Rayport and Sviolka 1995; Amit and Zott 2001; Ross et al. 2001). As den Hengst and Sol (2002:73) noted, ''the focus of efforts to improve performance of organizations has shifted from the organizational level to the inter-organizational level.'' Consequently, the literature on e-commerce has grown exponentially; it was recently reviewed by Urbaczewski et al. (2002) and Ngai and Wat (2002) and, more specifically in the area of B-to-B e-commerce by Gebauer and Shaw (2002). We note from these literature reviews that research related to e-commerce issues for SMEs is still slim, and research on the consequences of e-commerce is still far from conclusive. Gebauer and Shaw (2002: 11) list ''the impacts of B-to-B e-commerce on business processes, organizations and markets'' as being among the issues that merit the attention of B-to-B e-commerce researchers and call on a combination of research approaches that may be valuable, given the complexity of the research area.

2.1 Process-oriented approach

The complexity of e-commerce research is in part due to the fact that e-commerce does not constitute a single innovation but rather clusters of separate innovations that impact organizations in different areas and at different levels of their business processes, as is the case with IT research in general (Barua et al. 1995; Davern and Kauffman 2000).

As noted by Zhu and Kraemer (2002), the literature on the consequences of IT for productivity and business value can be classified into two broad categories: (1) the production-economics-based approach and (2) the process-oriented approach. A review of the literature on the first approach is addressed by Brynjolfsson and Yang (1996). The process-oriented approach has resulted in a stream of research that went beyond the economics-based approach by shedding light on the value creation process that IT initiatives have on organizations and on how that value could be measured (Crowston and Treacy 1986; Kauffman and Weill 1989; Barua et al. 1995; Mooney et al. 1995; Baron et al. 2000; Chircu and Kauffman 2000; Tallon et al. 2000). The approach is also relevant to practitioners and has generated many business process studies (Davenport 1992; Hammer and Champy 1993; Keen 1997). As Kauffman and Weill (1989) suggested, in IT research, the primary level of value analysis should be the technology's locus of impact on the

organization. The ''process-oriented'' approach recognizes business processes as the locus of impact of IT.

More recently, researchers in the area of e-commerce have found the process-oriented approach useful for studying e-commerce's impacts on adopting organizations, notably in conceptual and industry case studies (Subramaniam and Shaw 2002) as well as in some survey studies (Barua et al. 2001; Zhu and Kramer 2002; Lefebvre and Lefebvre 2003). This study builds on the process-oriented approach and proposes 36 thoroughly tested and validated business processes.

2.2 Benefits from e-commerce initiatives

Some benefits of e-commerce initiatives are similar to those usually derived from EDI but do not require the substantial investments associated with EDI; e-commerce is therefore considered as an attractive alternative for smaller firms (Boyer and Olson 2002:481). Past research on inter-organizational information systems (IOS) also points to the mutual benefits associated with increased levels of collaboration between business partners (see, for instance, Barett and Konsynski 1982). As such, previous work on IOS provides some interesting input with respect to B-to-B e-commerce.

The more recent literature on e-commerce reveals a number of associated benefits. First, access to international markets at minimal cost represents one crucial competitive advantage for SMEs (Lal 2002). Second, documented benefits derived from e-commerce also include reductions in transaction costs, especially for e-procurement (Chan and Lee 2003) and economies of scale such as consolidation of sales or group buying (Turner 2000). Taking a broader perspective, one concludes that e-commerce generates positive impacts on operations management (Gunasekaran et al. 2002) and improves efficiency and effectiveness (Kalakota and Robinson 2001; Turban et al. 2002). Third, in a manufacturing context, e-commerce creates potential opportunities such as faster product design, speedier ordering of parts and components, reduced lead times and lower inventory costs (Turner 2000).

Although the literature seems to demonstrate a positive bias by focusing on the benefits, some authors acknowledge that e-commerce may also constitute a drawback, especially for SMEs (Kleindl 2000; Drew 2003): Internet-based e-commerce potentially lowers the market entry barriers for all SMEs, including foreign competitors, and thus increases the level of competitive rivalry. Further, electronic marketplaces often increase the power of large firms and multinationals and lower the profit margins of smaller suppliers. As SMEs become integrated in supply chains, e-collaboration founded on the use of Web-based tools fosters firms' innovativeness, in the form of product, process or relational innovations (Lefebvre et al. 2003). Finally, the increased innovativeness may well put a strain on the rather scarce financial and human resources usually available in SMEs. E-commerce therefore increases the overall competitiveness of SMEs' environment, whereas the benefits associated with e-commerce are not clear-cut. This trade-off between benefits and drawbacks undoubtedly merits further investigation.

The SMEs seem to be lagging behind their larger counterparts in terms of e-commerce penetration (Coppel 2000; Kendall et al. 2001; Charles et al. 2002). In fact, "while CEOs of SMEs seem to recognize the importance of having Internet presence, only a small portion of them use the Internet for commercial purposes" (Grandon and Pearson 2003:1). The central premise of this paper is that SMEs reach different levels of e-commerce penetration in terms of breadth and depth and that derived benefits from e-commerce differ according to these levels of penetration.

3 Methodological issues

We will briefly address here some methodological issues related to the population and data collection (Sect. 3.1) and to the measurement of e-commerce initiatives and benefits (Sects. 3.2 and 3.3).

3.1 Population and data collection

A systematic sample from a governmental list of Canadian manufacturing SMEs was drawn. The list provided access to data such as a company's location and the name and e-mail address of its CEO. The chief executive officer was selected as the single informant as he or she acts as the "principal architect of corporate strategy" (Harrison 1992), including technological choices and investments (Lefebvre et al. 1997). CEOs of the selected firms were reached by e-mail and asked to participate in an on-line survey. Compared to a traditional mail questionnaire, an electronic survey offers certain advantages such as the creation of a more interactive and attractive instrument, the reduction in handling costs and response cycle time and the elimination of errors due to data re-entry (Couper 2000; Dillman 2000; Rogelberg et al. 2001). Moreover, generalized access to the Internet, which a few years ago was considered a potential shortcoming for on-line surveys, no longer represents an important issue since most North-American SMEs have Internet access.

No significant differences (goodness of fit tests) were found between respondents and non-respondents with respect to firm size. However, the response rate was slightly higher for urban areas. The overall response rate was 7.67%, which is quite acceptable for an electronic survey. A total of 230 manufacturing SMEs participated in the survey. Subsequent data analyses will be performed on 96 of these firms that indicated that they had adopted e-commerce applications.

3.2 Indicators used in the survey to assess e-commerce initiatives

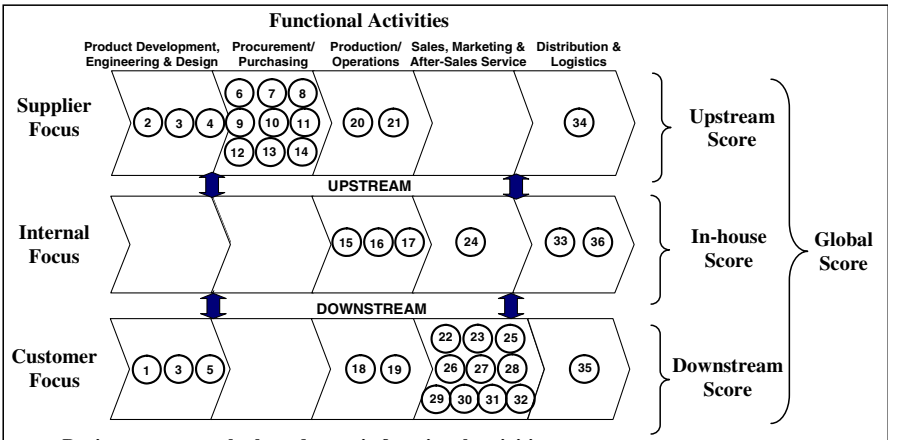
Few indicators appear to be truly useful in studying the impact of e-commerce on organizations. E-commerce metrics used in recent surveys mostly have focused on estimating dollar figures for sales and volumes of

e-commerce transactions. To assess the consequences of e-commerce on an organization, we ought to have indicators that permit to examine e-commerce initiatives at the locus of impact of the technology: the "business processes." Some recent research efforts have addressed this issue (Mathiyalakan and Velu 2001; Subramaniam and Shaw 2002; Zhu and Kraemer 2002). In a recent work, Elia et al. (2003) conducted a multi-stage study and identified some business processes that could be affected by e-commerce within manufacturing SMEs. Three main sources of information were used to develop and validate the indicators: (1) an analysis of previous surveys and studies of e-commerce penetration; (2) simulations of simple and advanced e-commerce applications carried out at a university laboratory; (3) results of focus groups. The survey presented here uses this validated set of indicators. Figure 1 displays the 36 business processes that were retained and classified under the five generic functional activities: product development, engineering and design; procurement/purchasing; production/operations; sales, marketing and after-sales service; and distribution and logistics. Depending on their main focus (Daniel and Myers 2000; Papazoglou et al. 2000; Lefebvre et al. 2003), business processes were classified into three broad categories: processes that are mainly shared with customers (downstream), processes that are mainly shared with suppliers (upstream) and processes that are mainly internal to the firm (in-house).

The technological complexity of an innovation has been widely recognized as an inhibitor to its rate of adoption (Tornatzky and Fleischer 1990; Rogers 1995). By supporting business processes electronically an organization assimilates related technologies, knowledge and skills. SMEs that adopt more complex e-commerce processes achieve higher levels of technology assimilation than those who adopt less complex ones. Therefore, in addition to calculating a score based on the presence or absence of one particular business process, we also proposed to capture the different levels of B-to-B e-commerce penetration with three composite scores (right; upper part of Fig. 1). These scores (upstream, in-house, downstream) indicators represent the weighted sum of business processes carried out electronically by each firm: the weight given to each business process corresponds to the relative degree of technological complexity associated with the 36 business processes, as assessed by a panel of 12 independent experts who were familiar with the manufacturing context and with the business processes involved. The Delphi method was retained. After two iterations, consensus was reached. Appendix 1 displays the relative degree of complexity of each of the 36 business processes. Inter-rater reliability between members of the panel ranges from excellent ($r > 0.90$) to good ($r = 0.64$).

The global score (i.e. all 36 business processes) is calculated using the following simple formula:

$$\frac{\sum_{i=1}^{n} c_i \times \mathrm{BP}_i}{\sum_{i=1}^{n} c_i} \times 100;$$



Business processes by broad generic functional activities:

Product Development, Engineering & Design:

1. Transfer documents and technical drawings to customers.
2. Transfer documents and technical drawings to suppliers.
3. Integrate software supporting product design (e.g. CAD/CAM, VPDM, PDM).
4. Do collaborative on-line engineering with suppliers.
5. Do collaborative on-line engineering with customers.

Procurement/Purchasing:

6. Seek out new suppliers.
7. Seek out products/services.
8. Buy products/services using electronic catalogs.
9. Buy products/services by electronic auction.
10. Buy products/services by issuing electronic calls for tenders.
11. Place and manage orders with suppliers.
12. Negotiate contracts (price, volume, etc.) with suppliers.
13. Make electronic payments to suppliers.
14. Access suppliers' product/service databases.

Production/Operations:

15. Automate the production floor using a manufacturing execution system (MES).
16. Integrate the MES into the management information system.
17. Ensure the management of quality assurance using the management information system.
18. Allow customers to access the company's inventories.
19. Access customers' inventories.
20. Allow suppliers to access the company's inventories.
21. Access suppliers' inventories.

Sales, Marketing & After-Sales Service:

22. Advertise the company and/or its products/services.
23. Seek out new customers.
24. Convert information on products/services into digital form.
25. Sell products/services using electronic catalogs.
26. Sell products/services by electronic auction.
27. Sell products/services by responding to electronic calls for tenders.
28. Negotiate contracts (price, volume, etc.) with customers.
29. Receive and manage customer orders.
30. Receive electronic payments from customers.
31. Access customers' product/service databases.
32. Offer customers after-sales services.

Distribution & Logistics:

33. Automate distribution/logistics using a logistics execution system (LES).
34. Allow distribution/transportation partners to access the information they need (SKU, quantity, delivery turnaround, etc.) in order to reduce time and costs related to distribution.
35. Optimize returns management ("reverse logistics").
36. Track products (purchased and sold) during transportation.

Fig. 1 Proposed typology of business processes by major functional activity and by business focus

where c_i = degree of complexity of business process i; $BP_i = 0$ when business process i is absent and $BP_i = 1$ when business process i is present. The three composite scores, namely the upstream score, the in-house score

and the downstream score, are calculated in a similar manner but are focusing on specific business processes that correspond to each of these three dimensions. Similarly, composite scores can also be derived for each of the five generic functional activities.

3.3 Measuring e-commerce benefits

Few organizations have formal methods to evaluate the benefits derived from e-commerce (Seddon et al. 2002), which explains the lack of data on these issues within organizations. In survey research, CEOs' perceptions were found to be a good proxy to evaluate realized strategic and operational value (Tallon et al. 2000; Seddon et al. 2002; Grandon and Pearson 2003). In the case of SMEs, B2B e-commerce initiatives could be driven by a customer, a supplier or other partner organization. Therefore, the CEO might not be directly responsible for the initiatives' outcomes. In this case, and without fully understanding how all possible factors affect CEOs' ratings, we cannot conclude that CEOs as single sources of information are unequivocally biased (Philipps 1981; Lefebvre et al. 1997). In this study, perceived benefits are measured using 7-point Likert scales: they were derived from a thorough literature review and reflect the types of benefits that can be achieved in a manufacturing environment. The list of benefits and its supporting literature are presented in Appendix 2. They were validated in a pre-test with 15 randomly selected manufacturing SMEs: on-site interviews with CEOs and top managers from these 15 firms were asked to complete the questionnaire in full and to provide comments in order to improve the data collection instrument.

4 Results and discussion

Statistical analysis was conducted in six consecutive steps:

1. Assessing the levels of B-to-B e-commerce adoption and deriving clusters of SMEs accordingly (cluster analysis—Table 1).
2. Validating the results from cluster analysis by examining the accuracies of prediction for cluster membership (discriminant analysis—Table 2).
3. Gaining a better understanding of the focus of e-commerce initiatives—i.e. clusters—by assessing the use of business processes within each of the generic functional activities (analysis of variance—Table 3 and frequency analysis—bottom part of Table 3 and Appendix 4).
4. Relating the focus of e-commerce initiatives to certain organizational characteristics (analysis of variance—Table 4).
5. Identifying the underlying dimensions or factors for the benefits derived from B-to-B e-commerce (factor analysis—Table 5).
6. Relating the levels of e-commerce adoption to the derived benefits (non-parametric analysis of variance—Table 6).

Table 1 Focus of e-commerce initiatives: results of cluster analysis ($n = 96$)

E-commerce initiatives	Group 1 Limited focus ($n_1 = 42$)	Group 2 Supplier focus ($n_2 = 16$)	Group 3 Customer focus ($n_{3\ =\ 32}$)	Group 4 Supplier and customer focus ($n_4 = 6$)	p[a]
Upstream score[b]	6.01	29.95	12.55	53.03	0.000
In-house score[b]	1.99	2.84	6.97	19.28	0.000
Downstream score[b]	8.68	13.53	29.97	43.07	0.000
Global score[b]	6.05	17.35	17.41	40.24	0.000

[a]p = level of significance of the Kruskall Wallis (or non-parametric ANOVA) tests. The levels of significance for the ANOVA tests are identical

[b]Maximum value = 100; minimum value = 0; these scores represent a weighted sum (see Sect. 3.2 for more details). The non-weighted sum is displayed in Appendix 3

Table 2 Multivariate validation of the four clusters

Actual group membership	Predicted[a] group membership			
	Group 1 ($n_1 = 37$)	Group 2 ($n_2 = 16$)	Group 3 ($n_3 = 30$)	Group 4 ($n_4 = 6$)
Classification results				
Group 1 ($n_1 = 42$)	83.30%			
Group 2 ($n_2 = 16$)		100.00%		
Group 3 ($n_3 = 32$)			93.80%	
Group 4 ($n_4 = 6$)				100%
Total correctly classified: 90.60%				

Discriminant functions	Eigenvalues	Wilks Lambda	χ^2	p
Other results				
1	3.78	0.07	239.91	0.000
2	1.8	0.35	96.76	0.000
3	0.03	0.97	2.47	0.116

[a]As predicted by the discriminant functions

4.1 Four distinct profiles of e-commerce adoption

Cluster analysis is conducted to form similar groups of SMEs based on the three proposed scores for e-commerce penetration: namely the upstream, in-house and downstream scores. The main objective of this analysis is to form clusters of firms which exhibit both high internal homogeneity and high external heterogeneity. The measure of distance retained for the cluster analysis is the Chebyshev metric (the maximum absolute difference in value for any of the three scores displayed in Fig. 1): this metric is appropriate since there is no need to remove the bias introduced by the differences in scales since the three scores are based on a maximum of 100. The hierarchical cluster procedure is the complete linkage procedure based on the maximum distance between firms and is also known as "the furthest neighbor approach."

Four distinct groups of firms can be identified from the cluster analyses (Table 1). The first group, which comprises 42 firms, corresponds to

Table 3 E-commerce focus and corresponding use of business processes by generic functional activity

E-commerce initiatives by generic functional activity	Group 1 Limited focus ($n_1 = 42$)	Group 2 Supplier focus ($n_2 = 16$)	Group 3 Customer focus ($n_3 = 32$)	Group 4 Supplier & customer focus ($n_4 = 6$)	P[a]
Product Development, Engineering & Design[b]	11.56	22.80	31.81	51.75	0.015
Procurement/Purchasing[b]	6.40	51.43	7.92	65.72	0.000
Productions/Operations[b]	1.39	1.64	3.35	11.33	0.165
Sales, Marketing & after-sales Service[b]	11.66	16.14	41.73	61.45	0.000
Distribution & Logistics[b]	0.00	0.00	3.57	19.79	0.000
Global score[b]	6.05	17.35	17.41	40.24	0.000

Business processes conducted electronically by more then :

25% of the SMEs belonging to group 1:

Rank[c]	Process #	
1	22.	Advertise the company and/or its products/services.
2	29.	Receive and manage customer orders.
3	23.	Seek out new customers.

50% of the SMEs belonging to group 2:

Rank	Process #	
1	7.	Seek out products/services.
2	6.	Seek out new suppliers.
3	8.	Buy products/services using electronic catalogs.
4	11.	Place and manage orders with suppliers.
5	14.	Access suppliers' product/service databases.

50% of the SMEs belonging to group 3:

Rank	Process #	
1	22.	Advertise the company and/or its products/services.
2	23.	Seek out new customers.
3	29.	Receive and manage customer orders.
4	31.	Access customers' product/service databases.
5	32.	Offer customers after-sales services.

50% of the SMEs belonging to group 4:

Rank	Process #	
1	6.	Seek out new suppliers.
2	7.	Seek out products/services.
3	29.	Receive and manage customer orders.
4	11.	Place and manage orders with suppliers.
5	8.	Buy products/services using electronic catalogs.
6	24.	Convert information on products/services into digital form.
7	32.	Offer customers after-sales services.
8	12.	Negotiate contracts (price, volume, etc.) with suppliers.
9	28.	Negotiate contracts (price, volume, etc.) with customers.
10	14.	Access suppliers' product/service databases.
11	23.	Seek out new customers.
12	22.	Advertise the company and/or its products/services.
13	2.	Transfer documents and technical drawings to suppliers.
14	25.	Sell products/services using electronic catalogs.
15	31.	Access customers' product/service databases.

[a] p = level of significance of the Kruskall Wallis (or non-parametric ANOVA) tests
[b] Maximum value: 100; minimum value: 0; these scores represent a weighted sum
[c] Ranks in decreasing order of use

firms with little e-commerce focus and adoption. These firms are probably in the beginning stages of e-commerce adoption and have not yet opted for a specific strategy. The second group ($n_2 = 16$) is supplier focused while the third ($n_3 = 32$) is much more focused on customers. As such,

Table 4 Characteristics of firms according to their e-commerce focus

Characteristics	Group 1 Limited focus ($n_1 = 42$)	Group 2 Supplier focus ($n_2 = 16$)	Group 3 Customer focus ($n_3 = 32$)	Group 4 Supplier and customer focus ($n_4 = 6$)	p[a]
Size (total annual sales) [b]	50.61	63.06	53.60	266.25	0.051
Level of exports[c]	15.09%	14.40%	15.67%	20.08%	0.537
Level of imports[d]	10.51%	17.07%	17.41%	28.84%	0.118
E-sales[e]	1.73%	3.60%	3.57%	23.02%	0.002
E-procurement[f]	2.36%	19.01%	3.26%	40.63%	0.000

[a] p = level of significance of the Kruskall Wallis (or non-parametric ANOVA) tests
[b] In millions of Canadian dollars
[c] Ratio of exports over total annual sales
[d] Ratio of imports over total annual procurement
[e] Ration of e-sales over total annual sales
[f] Ratio of e-procurement over total annual procurement

these two groups have significantly different e-commerce strategies. The fourth group ($n_4 = 6$) is both customer- and supplier-focused and also shows the highest in-house focus. This group is obviously ahead of the other three groups with respect to all dimensions of e-commerce adoption and demonstrates not only depth with respect to e-commerce focus but also breadth since they cover a broad range of applications. The overall score of e-commerce adoption is clearly the lowest for group 1 (6.05) and the highest for group 4 (40.24), as could be expected. However, it is remarkably similar for groups 2 and 3 (17.35 and 17.41, respectively). Although these two groups show a similar level of e-commerce penetration, their focus is also significantly different.

Additional interesting observations can be made from Table 1:

1. Group 4 seems to represent the exceptional SMEs that demonstrate both depth (i.e., fairly high global score of 40.24) and breadth (i.e., wide ranging efforts with relatively high values for the upstream, downstream and even, to a much lesser extent, in-house score (values of 53.03, 43.07 and 19.28). The number of these exceptional firms is limited ($n_4 = 6$) compared to the rather inexperienced firms from group 1 ($n_1 = 42$).
2. The in-house scores are lower compared to the upstream and downstream scores for any of the four groups. SMEs seem more inclined to respond to the requirements of their business partners than to foster the internal electronic integration: such a situation may not be sustainable in the long term as the more complex business processes will need to be executed electronically.

Are the clusters presented in Table 1 valid? The results presented in Table 1 show that the four groups of firms are significantly different ($p = 0.000$). Going one step further with a multivariate assessment of the validity of these clusters, the discriminant analysis conducted on the three scores allows one to correctly classify 90.60% of SMEs in their respective groups (Table 2). Group 1 has the lowest, but still quite acceptable, rate of classification (83.30%) while 93.80% of firms from group 3 were correctly

Table 5 Results of factor analysis on perceived benefits derived from e-commerce initiatives ($n = 96$)

Benefits derived from e-commerce initiatives	Factors		
	Factor 1 (firm efficiency)	Factor 2 (market growth)	Factor 3 (customer relationship management)
Reduction in delivery time (speed or dependability)	0.67	0.34	0.21
Reduction in procurement costs	0.63	0.58	0.06
Reduction in engineering, product development and design costs	0.70	−0.20	0.43
Reduction in manufacturing and inventory costs	0.87	0.20	0.17
Reduction in product manufacturing cycle time	0.80	0.35	0.11
Reduction in logistics and distribution costs	0.73	0.43	0.19
Increase in market share	0.24	0.90	0.09
Increase in revenues	0.24	0.88	0.19
Increase in customer service quality	0.25	0.03	0.84
Reduction in marketing, sales and aftersales costs	0.131	0.44	0.74
Percentage of variance explained	34.60%	25.90%	16.00%
Cumulative percentage of variance explained	34.60%	60.50%	76.50%
Cronbach alpha coefficients	0.90	0.91	0.62

Table 6 E-commerce focus and perceived benefits ($n = 96$)

Benefits derived from e-commerce initiatives	Group 1 Limited focus	Group 2 Supplier focus	Group 3 Customer focus	Group 4 Supplier and customer focus	p[a]
Efficiency	2.58	3.23	2.60	4.63	0.013
Market growth	3.25	3.12	3.41	5.00	0.164
Customer relationship management	3.32	3.50	4.23	4.90	0.029

[a] p = level of significance of the Kruskall Wallis (KW) tests (or non-parametric ANOVA). The ANOVA tests give slightly more significant results. Hence, KW tests which are more conservative are used here

classified. Perfect classification rates occur for firms in groups 2 and 4. The results presented in Table 1 therefore seem quite robust and valid.

4.2 Linking the focus of e-commerce initiatives to generic functional activities and to specific business processes

Table 1 revealed our distinct profiles corresponding to four groups of SMEs. We now propose to go one step further and examine the relative emphasis placed by these four groups of firms on each of the five generic functional activities (upper part of Table 3) and on each of the 36 related business processes (bottom part of Table 3 and Appendix 4).

The upper part of Table 3 displays results that are congruent with the focus of e-commerce initiatives. The four groups obtain significantly different scores for their e-commerce initiatives with respect to procurement/purchasing ($p = 0.000$) and to sales, marketing and after-sales service ($p = 0.000$). As might be expected, group 2 places the most emphasis on the functional activities that primarily focus on suppliers, with a procurement purchasing score of 51.43, while group 3 presents a high score for functional activities that are customer-oriented. The fourth group demonstrates the strongest commitment to e-commerce initiatives related to each of the five generic activities and represents the only group that carries out distribution and logistics activities electronically, at least to some extent. These results corroborate those found in Table 1.

Two additional interesting observations can be made:

1. Most SMEs seem to be involved in e-product development, engineering and design, with scores ranging from 11.56 for group 1 to 51.75 for group 4. The on-site pre-test interviews with 15 SMEs allow us to shed some light on an interesting finding: interactive applications such as product imagery are widely used in larger firms and thus are often required from their suppliers. These applications range from simple 2D visualization to more complex 3D tools such as CATIA.
2. The production/operations score remains quite low for all four groups. The low scores reflect the difficulties associated with these activities in an electronically mediated environment, due mainly to the lack of expertise found in smaller firms. The pre-test interviews also suggest that SMEs do

not necessarily grasp the true potential of such activities and basically respond to their customers' requirements. This result corroborates the low in-house scores displayed in Table 1.

Let us now examine the business processes that are conducted electronically in each of the groups. The bottom part of Table 3 displays the highest frequencies found in each group, while Appendix 4 gives the ranking of all 36 business processes by decreasing order of use within each group. According to Table 3, group 1, which represents the largest number of SMEs, is clearly lagging behind the other three groups: no single business process is conducted electronically in more than 50% of the firms in our sample and only three processes can be found in more than 25% of them; these three processes represent basic e-commerce initiatives (Web presence, simple interactions with customers and information search) which require minimal efforts by an SME to enable. Basic e-commerce initiatives that involved search processes ranked high in all four groups and appear to be conducted at an early stage of B2B e-commerce as SMEs reap associated benefits with minimal investments. The five business processes that are conducted electronically by at least 50% of the firms belonging to groups 2 and 3 correspond to their respective focus on suppliers (group 2) and customers (group 3). The fourth and last group presents a large number of business processes (15) that are carried out by electronic means in at least 50% of the SMEs. A closer look at these business processes indicates that these firms seem to be involved in e-collaboration with both upstream and downstream business partners.

In summary, the results presented in Table 3 clearly suggest that the breadth and depth of B-to-B e-commerce initiatives significantly differ for the four groups of firms, with the fourth group being well in the lead. The Kendall test (see Appendix 4) indicates almost full disagreement between the four groups ($p = 0.997$). The detailed information presented in Appendix 4 allows one to make an additional comment: five processes are not used by any of the SMEs in our sample, namely processes 15, 16, 20, 26 and 35—i.e. using and integrating MES (Manufacturing Execution Systems), allowing suppliers to access the company's inventories, selling products/services by electronic auctions, and reverse logistics—all of which require and support a high level of supply chain integration.

4.3 The focus of e-commerce initiatives and related organizational characteristics

Table 4 sheds some light on the characteristics (size, level of exports and imports, level of transactions conducted electronically) of firms in the four groups.

Two remarks are worth focusing on: First, group 4 firms differ significantly from the other three groups in all measured characteristics. Firms in this group have higher annual sales on average and tend to be more internationalized (level of exports and imports in regard of total sales). Not surprisingly, they also have the highest percentage of

transactions conducted electronically (e-sales and e-procurement). Second, the supplier-focused group (group 2) has a higher e-procurement rate than the limited-focus and customer-focused groups. However, the customer-focused group does not differ from groups 1 and 2 with regard to e-sales. This leads us to think that, although firms in this group support customer-oriented e-commerce initiatives, they do not do so to drive sales but rather to support other customer-related activities such as customer after-sales services.

4.4 B-to-B e-commerce benefits for manufacturing SMEs

In order to obtain a smaller, more meaningful set of dimensions for the benefits derived from e-commerce in a manufacturing SME context, a factor analysis using the principal component analysis model with varimax rotation was conducted. The factor analysis produced a clean and easily interpretable factor structure (Table 5) and the sampling adequacy test (Kaiser Mayer Olkin test) is very satisfactory (0.86); this suggests that the results from the factorial analysis are robust.

The analysis yields three factors which collectively explain 76.50% of the variance. The first factor points to improved efficiency and reflects the combined importance of cost reductions, lower inventories and shorter manufacturing cycle times for SMEs. The second factor corresponds to an increase in both market share and revenues, which constitutes the main impulse to growth of manufacturing SMEs. The third factor is related to customer relationship management with a strong contribution from the ''improved customer service quality'' dimension. The *a posteriori* construct reliability of these three factors, as measured by Cronbach alphas (0.90, 0.91 and 0.62 respectively, last line in Table 5), is adequate.

Accrued benefits from e-commerce applications vary between the four groups of firms (Table 6). The group with the lowest level of penetration (group 1) is also the one which derives the fewest benefits while the group with the highest level of penetration with respect to depth and breadth (group 4) is also the one which reaps the most benefits in terms of firm efficiency, market growth and customer relationship management. The supplier- and customer-focused groups' benefits (groups 2 and 3, respectively) seem to be in line with their selected strategies. Finally, customer relationship management benefits appear to be very important to all four groups, suggesting that customer focus is important for all groups of firms when e-commerce applications are involved.

5 Conclusion and future research

The results of this study should be interpreted in the light of certain limitations. First, the sample is small ($n = 96$) and contains only manufacturing SMEs that are engaged in B-to-B e-commerce. Second, each SME's results are derived from a single informant: its CEO. Third, statistical analysis

remains within the realm of exploratory research (descriptive analysis, cluster analysis, principal components factorial analysis). However, these limitations are offset to some extent by the research design and by the detailed statistical analyses. Focusing strictly on manufacturing SMEs minimizes the differences resulting from sectoral particularities and constitutes a first step prior to making broad generalizations. Furthermore, extensive efforts are made to validate the 36 business processes, which allow us to assess the breadth and depth of B-to-B e-commerce initiatives. These business processes were validated iteratively with five focus groups, assessed by a panel of 12 experts and pre-tested with on-site interviews with 15 SMEs. The results of the e-survey also seem to support the typology of the 36 business processes.

This study attempts to gain a better understanding of the gradual unfolding of e-commerce initiatives among SMEs by identifying the focus and the level of these e-commerce upstream, downstream or in-house initiatives. Significantly different groups of firms were identified with respect to these three dimensions and also with respect to the depth and breadth of e-commerce initiatives. This goes beyond the traditional linear views of e-commerce penetration. It further translated into differing benefits that firms gain from the use of e-commerce. The contributions of this paper are twofold. First, the proposed typology of the 36 business processes represents a valuable starting point as it pertains to the specific context of manufacturing SMEs. Additional business processes related to the context of larger firms (such as e-recruitment for instance) could be added if one wishes to extend the study to firms of all sizes. Some business processes pertaining to manufacturing could be removed in order to measure e-commerce penetration in services or in the retail industry.

Second, the evidence presented in this paper suggests that there is a positive relationship between increased adoption and cumulative benefits and that there is a fit or alignment between the two. The phenomenon of B-to-B e-commerce adoption among manufacturing SMEs does not seem to be a random or sporadic process but rather a phenomenon associated to the evolutionary learning process. This certainly warrants further investigation to better understand the cumulative effect of e-commerce benefits in organizations. The next research question could be: how does the learning process occur within and between organizations given that e-commerce is basically a cluster of interactive innovations?

Finally, further research could also investigate other factors affecting e-commerce value realization in the case of manufacturing SMEs. Notably, a comparative analysis between the different identified groups of SMEs on factors such as external stimuli for adopting e-commerce, or internal stimuli such as readiness or maturity level in terms of IT management. This would help us better understand what further distinguishes manufacturing SMEs that are realizing value from e-commerce from the ones that are not.

Appendix 1

Table 7

Table 7 The mean level of complexity [Within each of the five generic functional activities, business processes are listed in increasing degree of complexity (rounded to two decimals). The numbers in front of each business process refer to those presented in Fig. 1. The complexity score is based on Likert scales where 1 = the lowest and 7 = the highest.] for the 36 business processes as assessed by the panel of experts

Appendix 2

Table 8

Table 8 Benefits derived from e-commerce initiatives and supporting literature

No.	Benefits derived from e-commerce initiatives	Supporting literature
1	Reduction in delivery time (speed or dependability)	Young et al. (1999), Turner (2000), Frohlich and Westbrook (2002)
2	Reduction in procurement costs	Mukhopadhyay and Kekre (2002), Chan and Lee (2003)
3	Reduction in engineering, product development and design costs	Turner (2000), Kothandaraman and Wilson (2001), Turban et al. (2002)
4	Reduction in manufacturing and inventory costs	Turner (2000), Kothandaraman and Wilson (2001), Gunasekaran et al. (2002)
5	Reduction in product manufacturing cycle time	Turner (2000), Gunasekaran et al. (2002), Schneider (2003)
6	Reduction in logistics and distribution costs	Lancioni et al. (2000), Gunasekaran et al. (2002)
7	Increase in market share	Evans and King (1999), Turban et al. (2002), Schneider (2003)
8	Increase in revenues	Kalakota and Whinston (1997), Turban et al. (2002), Schneider (2003)
9	Increase in customer service quality	Kalakota and Whinston (1997), Honeycutt et al. (1998), Turban et al. (2002), Chan and Lee (2003)
10	Reduction in marketing, sales and after-sales costs	Kalakota and Whinston (1997), Gunasekaran et al. (2002), Turban et al. (2002)

Appendix 3

Table 9

Table 9 Focus of e-commerce initiatives: results of cluster analysis ($n = 96$) using non-weighted scores

E-commerce initiatives	Group 1 Limited focus ($n_1 = 42$)	Group 2 Supplier focus ($n_2 = 16$)	Group 3 Customer focus ($n_3 = 32$)	Group 4 Supplier and customer focus ($n_4 = 6$)	p[a]
Upstream score [b]	7.30	40.83	13.75	60.00	0.000
In-house score [b]	2.78	5.21	9.90	25.00	0.000
Downstream score [b]	11.76	16.02	37.11	48.96	0.000
Global score [b]	8.53	24.65	23.00	49.54	0.000

[a] p = level of significance of the Kruskall Wallis (or non-parametric ANOVA) tests
[b] Maximum value = 100; minimum value = 0; these scores represent non-weighted sums. The weighted sums are displayed in Table 1

Appendix 4

Table 10

Table 10 Business processes ranked according to their use by all four groups of firms

Process no.	Business processes	Rank in group 1 Limited focus ($n_1 = 42$)	Rank in group 2 Supplier focus ($n_2 = 16$)	Rank in group 3 Customer focus ($n_3 = 32$)	Rank in group 4 S. and C. ($n_4 = 6$)
Product development, engineering and design					
1	Transfer documents and technical drawings to customers	6	9	7	16
2	Transfer documents and technical drawings to suppliers	5	8	6	13
3	Integrate software supporting product design	18	21	11	19
4	Do collaborative on-line engineering with suppliers	14	22	17	21
5	Do collaborative on-line engineering with customers	8	12	14	20
Procurement/purchasing					
6	Seek out new suppliers	7	2	12	1
7	Seek out products/services	4	1	15	2
8	Buy products/services using electronic catalogs	19	3	18	5
9	Buy products/services by electronic auction	–[a]	18	–	22
10	Buy products/services by issuing electronic calls for tenders	–	7	–	18
11	Place and manage orders with suppliers	10	4	23	4
12	Negotiate contracts (price, volume, etc.) with suppliers	20	15	–	8
13	Make electronic payments to suppliers	15	17	22	26
14	Access suppliers' product/service databases	13	5	16	10
Production/operations					
15	Automate the production floor using a manufacturing execution system (MES)	–	–	–	–
16	Integrate the MES into the management information system	–	–	–	–
17	Ensure the management of quality assurance using the management information system	–	–	24	27

Table 10 (Contd.)

Process no.	Business processes	Rank in group 1 Limited focus ($n_1 = 42$)	Rank in group 2 Supplier focus ($n_2 = 16$)	Rank in group 3 Customer focus ($n_3 = 32$)	Rank in group 4 S. and C. ($n_4 = 6$)
18	Allow customers to access the company's inventories	–	–	–	29
19	Access customers' inventories	–	–	–	28
20	Allow suppliers to access the company's inventories	–	–	–	–
21	Access suppliers' inventories	23	20	21	24
Sales, marketing and after-sales service					
22	Advertise the company and/or its products/services	1	6	1	12
23	Seek out new customers	3	13	2	11
24	Convert information on products/services into digital form	9	11	10	6
25	Sell products/services using electronic catalogs	12	16	8	14
26	Sell products/services by electronic auction	–	–	–	–
27	Sell products/services by responding to electronic calls for tenders	22	24	20	17
28	Negotiate contracts (price, volume, etc.) with customers	21	23	9	9
29	Receive and manage customer orders	2	10	3	3
30	Receive electronic payments from customers	16	–	13	23
31	Access customers' product/service databases	17	19	4	15
32	Offer customers after-sales services	11	14	5	7
Distribution and logistics					
33	Automate distribution/logistics using a logistics execution system	–	–	–	30
34	Allow distribution/transportation partners to access the information they need	–	–	–	25
35	Optimize returns management ("reverse logistics")	–	–	–	–
36	Track products (purchased and sold) during transportation	–	–	19	–

Classified according to their e-commerce focus. Kendall test of accordance between the ranks in the four groups indicates almost complete disagreement ($p = 0.997$)

[a]When no firm in the corresponding group conducts the process electronically the process rank is not given

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