Abstract

In order to become ‘world-class’ enterprises, manufacturing SMEs have made sizable investments in Internet-related technologies as the infrastructure for e-business applications. To the extent that e-business is assimilated by the SME, it can significantly affect the firm’s key business processes and relationships such as servicing customers and collaborating with business partners. In this regard, an empirical study of 108 Canadian firms sought to answer the following questions: For what purposes are the Internet and the Web presently used, i.e., to what extent are e-business functions assimilated in manufacturing SMEs? What characteristics of the SMEs’ environmental, strategic, managerial, operational and technological context determine e-business assimilation? And ultimately, to what extent does e-business assimilation contribute to the growth and internationalization of manufacturing SMEs?

Keywords: e-business assimilation, e-commerce assimilation, Internet use, Web use, SME, small business, manufacturing, growth, export, performance

INTRODUCTION

Many small and medium-sized enterprises (SMEs) presently evolve in a complex business environment, characterized by globalization, the internationalization of markets, and the need for greater efficiency, effectiveness and competitiveness based on innovation and knowledge. This has put increasing pressure upon the management of these firms, especially manufacturing SMEs that must now compete globally (Cagliano and Spina 2002). In order to lower their operating costs, increase productivity and quality, and respond to the increased requirements of their customers and other business partners, a number of these firms scan the technological environment and make sizable investments in implementing Internet-based or Web-based technologies as the infrastructure for e-business applications (Kleindl 2000). To the extent that e-business is assimilated by the SME, it can significantly affect the firm’s key business processes and relationships such as servicing customers and collaborating with business partners (Norris et al. 2000).

The adoption and assimilation of information technology (IT), and of the Internet in particular, are

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deemed to be influenced by a number of environmental, organizational, technological and individual factors. Whereas IT adoption refers to whether or not an organization uses a technology, IT assimilation essentially refers to the breadth and depth of this use (Agarwal et al. 1997; Armstrong and Sambamurthy 1999; Dholakia and Kshetri 2004). While a significant amount of research has been done on the determinants of e-business in large firms, much less is known in regard to SMEs, especially manufacturing SMEs. As high-growth SMEs are largely deemed to provide added opportunities for manufacturing knowledge and know-how within a particular industry (e.g., plastics) or industrial activity (e.g., machining). This makes for a more complex commercial cycle linking customers, suppliers and other business partners (Cagliano et al. 2001).

Using the Internet and the Web is deemed to provide operational, managerial and strategic advantages such as greater internal and external process integration, closer links with customers and other business partners, greater market penetration and expansion capabilities, richer information for decision-making, better competitive intelligence, and greater access to external resources and expertise that contribute to the development of small businesses (Jeffcoate et al. 2002). E-business is also deemed to provide added opportunities for manufacturing SMEs to internationalize their activities (Kula and Tatoglu 2003). As high-growth SMEs are largely responsible for increases in the economic development of industrialized countries, both in terms of employment and commercial balance, governments have promoted e-business as a means to sustain and increase this development (Peet et al. 2002). However, there is presently not enough empirical evidence as to the actual effects of e-business upon the development of manufacturing SMEs, be it in terms of growth or global expansion.

In order to further our knowledge on the use of the Internet and the Web in manufacturing SMEs, the present research seeks through an empirical study of 108 Canadian firms to explore the following questions: For what purposes are the Internet and the Web presently used, i.e., to what extent are e-business functions assimilated in manufacturing SMEs? What characteristics of the SMEs’ environmental, strategic, managerial, operational, and technological context are associated with e-business assimilation? And ultimately, to what extent does e-business assimilation contribute to the growth and internationalization of manufacturing SMEs?

**THEORETICAL BACKGROUND**

The adoption and assimilation of IT has been analysed most often in terms of innovation, including studies on EDI and e-business. While Rogers’ (1995) classical diffusion of innovation model has served as a theoretical basis for many of these studies, it needs to be enriched when innovations relate to complex technologies with an inter-organizational locus of impact, for which adoption and usage decisions are linked (e.g., when imposed by business partners), and when innovations are adopted and used by organizations (as opposed to being adopted and used autonomously by individuals) (Eveland and Tornatzky 1990; Gallivan 2001). In the absence of a more general theory of innovation, Fichman (2000) notes that researchers should develop mid-range theories ‘tailored to specific classes of technologies [e-business technologies in this case] and/or particular adoption contexts [in this case, manufacturing SMEs].’

With this in mind, a number of studies have successfully used Tornatzky and Fleischer’s (1990) technology-organization-environment (TOE) framework to explain the assimilation of e-business, emphasizing three groups of determinants or predictors: 1) characteristics of the environmental context such as external pressures from the firm’s business partners (Raymond and Bergeron 1996); 2) characteristics of the organizational context such as the firm’s structure and resources (Gibbs and Kraemer 2004), including the perceptions of the organization’s leaders or decision-makers (Kuan and Chau 2001); and 3) characteristics of the technological context, including both intra and inter-organizational technologies already assimilated by the firm (Xu et al. 2004; Zhu et al. 2003).

An organization’s propensity to grow is conditioned by the opportunities provided and the constraints imposed by its environment. In this regard, the communication environment in the form of information sources and communication channels can be determinant (Rai 1995), particularly in the small business context where the firm’s external information network has been found to influence its performance (Barth 2003). With the advent of globalization and new organizational forms such as the ‘extended’ enterprise, some small and medium-sized firms, and high-growth firms in particular, have been found to develop through
networks that link them with customers, suppliers, competitors and other business partners in collaborative relationships (Hanna and Walsh 2002), using new Internet and Web-based technologies in particular to increase the intensity of their communication activities (Vescovi 2000).

Among the organizational characteristics thought to influence the assimilation of IT, the small firm’s strategy plays a primary role (Lefebvre et al. 1992; Premkumar 1992). The assimilation of an IT innovation such as e-business is intertwined with the firm’s business strategy, be it to reduce costs and reengineer business processes, to increase product/service differentiation, to achieve growth by developing new products/services and entering into new markets, or to develop strategic alliances (Kettinger and Teng 1998). For SMEs, strategic goals are embodied in the owner-manager’s desire to grow by developing the firm’s networks through partnerships, products through innovation, and markets through internationalization (Raymond and Bili 1997).

Diffusion of innovation theory has identified many characteristics that can determine an individual’s propensity to adopt an innovation and use it for his or her own purposes (Rogers 1995). When aggregated at the enterprise-level or associated to leaders or key decision-makers (e.g., SME owner-managers), individual attributes would obviously also affect the organizational assimilation of IT (Thong 1999). Hence, empirical studies have found that characteristics such as managerial tenure, education level and professionalism are predictors of innovation assimilation (Damanpour 1991; Fichman and Kemerer 1997).

The manufacturing context or production environment represents another fundamental aspect of the organizational context of SMEs. The basic type of the manufacturing process chosen by a firm is governed by its resources, by its competitive position and by the nature of the goods to be produced. The production environment then determines various characteristics required in terms of production and information processing capabilities (Grover and Malhotra 1999). Hence, mass production (‘make-to-stock’) requires more standardization, whereas discrete production (‘make-to-order’), the type of production most often found in SMEs, requires greater manufacturing and IT flexibility (Subash Babu 1999).

The technological context of small manufacturing firms is characterized above all by the nature, flexibility and integration of the manufacturing technology used to produce goods and render services to customers. In this regard, increased requirements for competitiveness, innovation and quality, have led many SMEs to make sizable investments in computer-based manufacturing technologies such as computer-aided design and manufacturing (Mechling et al. 1995). They have also invested, be it voluntarily or under pressure from business partners, in advanced computer-integrated manufacturing applications such as MRP II and now ERP to plan, command and control manufacturing resources and operations and link them with other intra- and inter-organizational systems (Kathuria and Igbia 1997). Taken together, these technologies and applications constitute advanced manufacturing technologies (AMT) that are compatible, in terms of enterprise integration, to a varying degree with the SMEs’ use of Internet and Web-based IT (Olhager and Rudberg 2003).

The effects of e-business upon the growth, competitiveness or performance of SMEs can be examined in terms of business value creation (Amit and Zott 2001). A market driven perspective, based on Porter’s (1991) competitive forces framework, can be used to examine the potential and actual effects of Web-based applications. In this perspective, e-business is meant to strengthen the relationship between a firm and its customers as it differentiates itself from its competitors, becomes a low cost producer, or identifies a market niche (Ives and Learmonth 1984; Kleindl 2000). Complementing the competitive forces framework with value chain analysis, e-business can provide SMEs with new ways to outperform their rivals and to create new business opportunities by identifying activities that contribute directly to performance and looking outside operational boundaries (Levy et al. 1999).

A complementary perspective that can be used to analyse the contribution of Web-based applications to business value is the resource-based view of the firm (Mata et al. 1995; Melville et al. 2004). Based on Penrose’s (1959) description of the firm as a bundle of resources, it is posited that the growth of the firm is both facilitated and limited by management’s search for the best usage of available resources. In this perspective, e-business resources can involve both internal and external capabilities, i.e., Internet and Web-based applications implemented to respond to market requirements, to establish relationships with business partners and understand competitors, and to enable e-business partnerships, e-business planning and change management (Wade and Hulland 2004).

RESEARCH MODEL AND HYPOTHESES

Founded on the TOE framework, the research model is presented in Figure 1. Five constructs that represent the firm’s environmental, strategic, managerial, operational and technological context are deemed to influence a manufacturing SME’s assimilation of electronic business activities. In this study, the assimilation of e-business is conceptualized as the variety of business functions or activities that are supported by the organization’s use of the Internet (including intranet and extranets) and the Web. The first type of business function supported by this use is communicational and informational
(e-communication), the second is more strategic in nature (e-business intelligence) while the third is transactional and collaborative (e-commerce and e-collaboration). From this point of view, e-business assimilation is deemed to be more extensive when the firm uses the Internet and the Web in support of more functions. Two other constructs, deemed to be affected by e-business assimilation, represent the SME's development in terms of growth and internationalization.

Environmental context of e-business in manufacturing SMEs

Many small manufacturers must now operate within a business environment characterized by the emergence of new organizational forms such as the network or extended enterprise, whose information infrastructure is based upon inter-organizational systems and technology (Johnston and Wright 2004). In a networked business environment, manufacturing SMEs would require Internet and Web-based capabilities to better support supply chain management and customer relationship management in particular. The emphasis placed upon communication and cooperation in such an environment is conducive to the assimilation of the B2B form of e-business. Greater use of the Internet and the Web would thus result from increased networking intensity on the part of the SME, that is, from the establishment of more partnerships with its customers, distributors, suppliers, competitors and other business partners such as research centres and consultants.

H1 – The greater the firm’s networking intensity, the greater its assimilation of e-business.

Strategic context of e-business in manufacturing SMEs

A firm’s strategic orientation or posture is its response to its environment. As this environment becomes more hostile or complex, SMEs with a more aggressive or more entrepreneurial orientation increase their competitiveness by seeking new markets and putting emphasis on technological leadership and new product/market combinations (Özsomer et al. 1997). Increased complexity in the environment is also seen as causing the acquisition of competitive, market and technological information to be more continuous, variant and wide-ranging (Julien et al. 1996). The strategic orientation of the SME must also be in alignment with its strategic management of IT (Bergeron et al. 2001), including the Internet (Porter 2001). Given the goals of a more
aggressive strategy in terms of market, product and technological developments, one expects e-business to be called upon more in support of such developments.

H2 – The more aggressive the firm’s strategic orientation, the greater its assimilation of e-business.

Managerial context of e-business in manufacturing SMEs

Small firms are deemed to be ‘organic’ to the extent that their strategy, structure and culture are embodied by the entrepreneur or the chief executive. The primary goals and characteristics of entrepreneurs are thus crucial in determining the firm’s innovativeness and orientation toward product-market development and technological sophistication (Miller 1993). In this regard, small business studies have shown that the previously acquired knowledge and experience of chief executives condition their behaviour as users of IT (Riemenschneider and Mykytyn 2000). In addition, a key component in the small firm’s e-business learning experience is its leader’s individual learning (Raymond and Bili 2000). Domain-specific knowledge that comes with experience in a specific industry or sector as well as more general knowledge obtained from a higher education would thus influence the chief executive’s awareness of the various e-business functions and applications to be assimilated by the organization, hence the third research hypothesis:

H3 – The greater the experience and education of the firm’s chief executive, the greater its assimilation of e-business.

Operational context of e-business in manufacturing SMEs

The appropriate choice of advanced manufacturing technologies is influenced by the manufacturing process structures used by an organization, i.e., by its production environment (Kathuria and Igbaria 1997). The flexibility required within a ‘make-to-order’ production environment has led SMEs to implement computer-integrated manufacturing (Ari Samadhi and Hoang 1995). In parallel fashion, make-to-order companies are seen to increase their level of vertical integration and improve their manufacturing planning and control decisions through e-business applications that allow them better to communicate and exchange information with their customers and suppliers (Ollhager and Rudberg 2003). Given the greater complexity of buyer–seller relationships in a make-to-order production environment, the fourth hypothesis follows:

H4 – The more the firm’s production environment is of the ‘make-to-order’ type, the greater its assimilation of e-business.

Technological context of e-business in manufacturing SMEs

Advanced manufacturing technologies are deemed to ‘significantly impact the design and outcomes of core organizational processes’ (Brandyberry et al. 1999: 995). In looking at the links between strategy, AMT and performance, some studies have stressed the information processing capability inherent in AMT in addition to the flexibility dimension (Kotha and Swamidass 2000). By linking with the information outputs and inputs of internal systems and applications such as CAD/CAM, MRP II and ERP, e-business applications can increase the manufacturing SME’s level of external integration through their enabling of design and production information exchanges with business partners, coordination of trans-organizational business processes (e.g., just-in-time or synchronous production with ‘extended’ ERP), and inter-organizational collaboration within a networked environment (Norris et al. 2000). Given the compatible and complementary nature of e-business and advanced manufacturing applications, the fifth hypothesis follows:

H5 – The greater the firm’s assimilation of advanced manufacturing technologies, the greater its assimilation of e-business.

Growth and internationalization outcomes of e-business in manufacturing SMEs

Based on prior IT business value research, it has been implicitly assumed that Web-based applications have positive impacts upon organizational performance, even though empirical results have often been inconclusive due to measurement limitations (Barua and Mukhopadhyay 2000). These applications are especially apt to redefine markets by ‘levelling the playing field’ for SMEs, thus enabling growth and internationalization strategies (Fariselli et al. 1999; Tiessen et al. 2001). Hence, the assimilation of e-business is not an end in itself for the manufacturing SME but a mean to enhance its business performance, subject to its strategic goals. Growth-seeking SMEs would achieve their goal through the advantages provided by e-business (Sadowski et al. 2002). Greater penetration of existing markets and development of new markets can be enhanced through the better competitive intelligence, greater customer satisfaction, improved marketing and sales practices (‘one-to-one’ marketing), and tighter
relationships with distributors brought about by implementing e-business applications (De Toni and Nassimbeni 2001). Manufacturing SMEs who seek to export to increase their sales when local markets are stagnant may also view e-business a vector of internationalization. Whereas participating in networks may render the SME more competitive at the international level, achieving ‘world-class’ status by enhancing its supply chain management (Hendry 1998) and its customer relationship management (Hanna and Walsh 2002). Given that e-business assimilation, notably EDI assimilation, provides a number of operational and strategic advantages to manufacturing SMEs such as reducing operation cycle time and increasing service quality (Bergeron and Raymond 1997), two hypotheses follow:

H6 – The greater the firm’s assimilation of e-business, the greater its growth.
H7 – The greater the firm’s assimilation of e-business, the greater its internationalization.

METHODOLOGY

The data used in the study were obtained from the PDC® database (St-Pierre and Delisle 2005), containing information on more than 350 manufacturing SMEs located in the province of Québec, Canada. With the collaboration of an 800-member industry association to which most of these firms belong, the database was created by having the SMEs’ chief executive and functional executives such as the controller, human resources manager and production manager fill out a questionnaire to provide data on the practices and results of their firm. In exchange for these data, the firms are provided with a complete comparative diagnostic of their overall situation in terms of performance and vulnerability. Anonymity of the questionnaire data and resulting diagnostic is preserved by the industry association, which assigns an identification code to each firm. Out of these firms, 108 came back for a second diagnostic a year later and were then questioned about their use of the Internet and the Web. Questionnaire data, including sales and export data, were also updated to reflect changes in the last year. Annual sales of the sampled organizations range from $(Can.) 1.4 M to $55 M, with a median of $7.6 M. Approximately 40% are ‘small’ (19–49 employees), whereas the rest are ‘medium-sized’ (50–336 employees), the median number of employees being 60. Over 15 industrial sectors are present, including metal products, wood, plastics and rubber, electrical products, food and beverages, and machinery.

In assessing the environmental context, the firm’s networking intensity is measured by the number of distribution, marketing, design and R&D partnerships established with customers, suppliers and other third-parties such as research centres (Gulati 1998). As the key informant on the firm’s strategic orientation, the chief executive (CEO) is asked to rate the aggressiveness with which new markets were developed and new products are launched, and the proactiveness with which new technologies are introduced, on scales adapted from Covin and Slevin (1989) and Julien and Raymond (1994). The production environment is assessed by the proportion of total production that is done in ‘make-to-order’ mode as opposed to mass or continuous production modes (Mechling et al. 1995). Brandyberry et al.’s (1999) classification is used to assess the firm’s level of AMT assimilation: level 1) stand-alone AMT (technologies such as CAD, CNC, automated handling of materials, and industrial robots); level 2) functionally oriented AMT (CAM and FMS); and level 3) computer-integrated manufacturing (CIM, i.e., applications such as CAD/CAM, MRP II and ERP that involve enterprise-wide integration).

The measure of e-business assimilation is based on a list of business functions for which the Internet and the Web is used by the firm. The grouping of these various functions corresponds to various stages of e-business assimilation, as adapted to the manufacturing SME context from previous studies (Raymond and Bergeron 1996; Kula and Tatoglu 2003; Levy and Powell 2003; Xu et al. 2004). The extensiveness of each type of use is measured by counting the number of activities checked by the respondents. Growth is assessed by the average sales increase over the past three years whereas internationalization is measured by the mean percentage of sales turnover that has been generated via exports over the past two years (Kalantaridis 2004).

RESULTS

As shown in Table 1, the sampled manufacturing SMEs tend to use the Internet (including intranet and extranets) and the Web more in terms of communication and e-business intelligence than in terms of e-commerce and e-collaboration. The descriptive statistics of the research variables follow in Table 2.

In testing the relationships hypothesized by the research model, structural equation modelling (SEM) was used. The partial-least-squares (PLS) method was chosen in preference to other SEM methods such as LISREL, since it is more appropriate in the initial phase of developing and verifying theories (Fornell and Bookstein 1982). PLS is also robust in that it does not require a large sample or normally distributed multivariate data (Fornell and Larcker 1981).
Test of the measurement model

The PLS method simultaneously assesses the theoretical propositions and the properties of the underlying measurement model. Internal consistency of measures, i.e., their unidimensionality and their reliability must be verified first. The observable variables measuring a non-observable construct (or latent variable) must be unidimensional to be considered unique values.

Unidimensionality was satisfied by retaining variables whose loadings were above 0.5, indicating that they share sufficient variance with their related construct. Thus, two variables, distribution partnerships and owner-manager education, had to be initially removed from the measurement model to insure construct unidimensionality. Reliability can be verified by considering the value of the rho coefficient, defined as the ratio between the square of the sum of the loadings plus the sum of the errors due to construct variance (Fornell and Larcker 1981). A rho greater than 0.8 indicates that the variance of a given construct explains at least 80% of the variance of the corresponding measure. As shown in Table 3, this is the case for all the constructs in the research model. The third property to be verified is discriminant validity. It shows the extent to which each construct in the research model is unique and different from the others using the correlations between each pair of constructs as criteria. The correlation between constructs must be less than the square root of average variance extracted (AVE) from each by its measures (Fornell and Larcker 1981); this is shown to be the case in Table 3.

Test of the theoretical model

The research hypotheses are tested by examining the direction, strength and level of significance of the path coefficients calculated by the PLS method, as shown in Figure 2.

- H1: The path coefficients first confirm that the environmental context influences the extent to which the sampled manufacturing SMEs have assimilated e-business. The firm’s networking intensity, both upstream and downstream in the value-chain in the form of design, R&D and marketing partnerships, is found to determine their use of the Internet and the Web for transaction or collaboration and business intelligence purposes, but not for communication or information purposes. Co-design of products and joint R&D between the SME and its business partners would be enhanced by the greater collaborative capabilities provided by the e-collaboration dimension of e-business (say, through electronic meetings). Sales and marketing partnerships would be supported by the greater commercial capabilities provided by the e-commerce dimension (say, through an e-marketplace shared by SMEs in the same manufacturing sector) and the greater commercial and competitive knowledge acquisition and diffusion capabilities provided by e-business intelligence.

- H2: Manufacturing SMEs whose strategic orientation is more aggressive in regards to new markets, products and technologies are found to assimilate e-business more extensively for purposes of communication or information, and transaction or collaboration with business partners, but not for business intelligence purposes. Firms in which the competitive strategy is based on developing new markets or on maintaining market share by improving their products and services through new technologies would first look to e-communication in order to promote the firm, its products and services better, and to communicate with existing customers more efficiently. More entrepreneurial SMEs would also look to e-commerce and e-collaboration technologies in their capacity to support the firm’s market development (growth and internationalization) and product development (quality and innovation).

- H3: The hypothesis that the managerial context influences the assimilation of e-business is partly confirmed. SMEs are found to use e-communication, e-commerce and e-collaboration more when led by a chief executive with more experience in the sector of
Table 2. Descriptive statistics of the variables in the research model

<table>
<thead>
<tr>
<th>Variable</th>
<th>mean</th>
<th>med.</th>
<th>s.d.</th>
<th>min.</th>
<th>max.</th>
</tr>
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<tbody>
<tr>
<td>Networking intensity&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>design and R&amp;D partnerships</td>
<td>1.0</td>
<td>0.0</td>
<td>1.4</td>
<td>0</td>
<td>5</td>
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<tr>
<td>marketing partnerships</td>
<td>0.7</td>
<td>0.0</td>
<td>1.0</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>distribution partnerships</td>
<td>0.4</td>
<td>0.0</td>
<td>0.7</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Aggressiveness of strategic orientation</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>development of new markets/products&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.1</td>
<td>2.0</td>
<td>0.9</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>introduction of new technologies&lt;sup&gt;c&lt;/sup&gt;</td>
<td>2.8</td>
<td>3.0</td>
<td>1.1</td>
<td>1</td>
<td>4</td>
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<tr>
<td>Managerial context</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>chief executive’s experience&lt;sup&gt;d&lt;/sup&gt;</td>
<td>18</td>
<td>16</td>
<td>10</td>
<td>0</td>
<td>46</td>
</tr>
<tr>
<td>chief executive’s education level&lt;sup&gt;e&lt;/sup&gt;</td>
<td>3.3</td>
<td>4.0</td>
<td>0.9</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Manufacturing context</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>type of production&lt;sup&gt;f&lt;/sup&gt;</td>
<td>37</td>
<td>10</td>
<td>42</td>
<td>0</td>
<td>100</td>
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<td>Manufacturing technology</td>
<td></td>
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<tr>
<td>assimilation of AMT&lt;sup&gt;g&lt;/sup&gt;</td>
<td>1.8</td>
<td>1.0</td>
<td>0.9</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Assimilation of e-business&lt;sup&gt;h&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>communicational/informational functions</td>
<td>2.8</td>
<td>3.0</td>
<td>1.1</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>business intelligence functions</td>
<td>1.5</td>
<td>2.0</td>
<td>1.3</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>transactional/collaborative functions</td>
<td>0.6</td>
<td>0.0</td>
<td>0.7</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Growth</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% sales growth&lt;sup&gt;i&lt;/sup&gt;</td>
<td>20</td>
<td>12</td>
<td>49</td>
<td>-33</td>
<td>460</td>
</tr>
<tr>
<td>Internationalization</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% sales exported&lt;sup&gt;j&lt;/sup&gt;</td>
<td>2.3</td>
<td>0.0</td>
<td>13.0</td>
<td>0</td>
<td>100</td>
</tr>
</tbody>
</table>

<sup>a</sup> number of partnerships with prime contractors, customers, suppliers, competitors, research centres, colleges and universities, and other SMEs

<sup>b</sup> 1: reactive (33%), 2: defensive (20%), 3: innovative (47%), 4: very innovative (0%)

<sup>c</sup> 1: very prudent (12%), 2: prudent (25%), 3: competitive (28%), 4: innovative (35%)

<sup>d</sup> number of years in the industry

<sup>e</sup> 1: grade-school (4%), 2: high-school (13%), 2: college (30%), 3: university (53%)

<sup>f</sup> percentage of production done on a ‘make-to-order’ basis

<sup>g</sup> 1: stand-alone AMT (33%), 2: functionally oriented AMT (12%), 3: CIM (55%)

<sup>h</sup> number of different business functions for which the Internet and the Web are used (see Table 1)

<sup>i</sup> averaged for the past two years

<sup>j</sup> export sales / total sales

Table 3. Reliability and discriminant validity assessment of the measurement model

<table>
<thead>
<tr>
<th>Latent variable</th>
<th>ρ&lt;sup&gt;a&lt;/sup&gt;</th>
<th>1&lt;sup&gt;b&lt;/sup&gt;</th>
<th>2.</th>
<th>3.</th>
<th>4.</th>
<th>5.</th>
<th>6.</th>
<th>7.</th>
<th>8.</th>
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<td>1. Networking intensity</td>
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<td>.04</td>
<td>1.0</td>
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<sup>a</sup> construct reliability coefficient=(Σλ<sup<r></sup>λ<sup<r></sup>)/((Σλ<sup<r></sup>λ<sup<r></sup>)+Σ(1−λ<sup<r></sup>^2))

<sup>b</sup> diagonal: (average variance extracted)<sup<r></sup>=(Σλ<sup<r></sup>^2/n<sup>r></sup>)<sup<r></sup>/2

sub-diagonals: correlation=(shared variance)<sup<r></sup><sup<r></sup>/2
activity. Here, a tentative explanation would be that more experienced leaders possess greater managerial competencies in regard to achieving manufacturing flexibility and integration, and are thus in a better position to ascertain the enabling role of e-business in this regard. They may also have developed over the years a combination of manufacturing resources that uniquely ‘fits’ their firm’s operating and external environments, and thus renders them less uncertain as to the eventual effects of e-communication, e-commerce, and e-collaboration upon their firm’s manufacturing strategy and performance.

- **H4:** A significant but negative path coefficient associates the production environment with the e-commerce and collaboration dimension of e-business. This result would indicate that the greater complexity of the inter-organizational business processes associated with ‘make-to-order’ production make them more difficult to reengineer with Internet and Web-based technology, as opposed to the simpler catalogue-based buying and selling processes associated with ‘make-to-stock’ production. Also, make-to-order is a manufacturing process structure with greater exigencies in terms of product variety and flexibility that would lead SMEs to increase their assimilation of e-business intelligence, as these firms require richer and wider-ranging information in order to evaluate their competitors, identify potential customers, and find new technologies.

- **H5:** The technological context was partly confirmed as a determinant of e-business assimilation in small manufacturing firms. More precisely, the path coefficients indicate that the more integrated SMEs are in terms of their assimilation of advanced manufacturing technologies, the more they use the Internet and the Web for business intelligence purposes. As the other dimensions of e-business, namely e-communication, e-commerce and e-collaboration were positively but not significantly influenced by AMT assimilation, this could tentatively mean that in most manufacturing SMEs, technologies and systems such as CAD/CAM or ERP have yet to be integrated with Internet technologies through inter-organizational systems such as shared-CIM or extended-ERP.

- **H6:** Path coefficients indicate that the growth of manufacturing SMEs is positively and significantly
influenced by their use of the Internet and the Web to sell their products and services, and to collaborate with their business partners in developing new products. As expected, the enhanced sales, marketing and product development capabilities brought about by e-commerce and e-collaboration translate into increased sales. It would also seem plausible that the other stages of e-business assimilation, that is, e-communication and e-business intelligence, would have a more indirect effect on sales growth, that is, through an intermediate effect on other determinants of growth such as customer satisfaction.

- H7: The last hypothesis could not be confirmed in that e-business assimilation was not found to positively influence the internationalization of manufacturing SMEs. A significant but negative path coefficient does however associate greater use of e-business intelligence with less export performance. Here, one could argue for the presence of a reverse causality between internationalization and e-business assimilation. It could be that the less-internationalized SMEs are the ones that require more Internet and Web-enhanced capabilities in terms of prospecting for clients abroad and garnering intelligence on the global competition. The cross-sectional as opposed to longitudinal nature of the study renders this argument speculative however.

Globally, these results indicate that the hypothesized antecedents of e-business assimilation in manufacturing SMEs explain a significant percentage of variance in e-communication (20%), e-business intelligence (12%), and e-commerce and collaboration (23%). In terms of growth, the assimilation of e-business by manufacturing SMEs explains 4% of these firms’ sales growth and 5% of their export performance as there are obviously many other factors that contribute to these firms’ performance.

IMPLICATIONS AND LIMITATIONS

The results of this study have implications for researchers as well as for managers of small and medium-sized manufacturing firms. Given the previous empirical evidence on e-business in SMEs, our results confirm that one must not only look at the adoption rate of Internet and Web-based manufacturing technologies. One must also look at their assimilation level to obtain richer insights as to why and how small manufacturers use e-business. In this regard, the concept of e-business assimilation as operationalized in this study seems promising as small manufacturers were found to vary significantly in their use of the Internet and the Web. For instance, it is one thing to implement a website that serves as ‘brochureware’ (Levy and Powell 2003), as most manufacturing SMEs have done already, but it is quite another to interact electronically with their business partners’ R&D or marketing department, as 30% of the firms studied here have done. Researchers who seek to understand further the actual benefits that accrue to small firms from their assimilation of e-business could utilize this concept in future studies in lieu of adoption.

Given the antecedents of e-business assimilation found in this study, the basic link between strategy and technology assimilation stands confirmed, notwithstanding the individual or entrepreneurial nature of the small manufacturer’s strategic orientation. How the chief executive perceives technology and the extent to which he or she pursues product and process innovation can thus be a predictor of the firm’s assimilation of e-business. In this regard, identifying a mismatch between the firm’s strategy, manufacturing environment, manufacturing technology, and its use of e-business should trigger corrective action.

One must also take into account the new realities of global competition in which large and small firms work together within networks. Managers of small firms who enter into long-term agreements with prime contractors or who act as subcontractors for a few large customers must be prepared to increase their firm’s assimilation of e-business in partnership with rather than under pressure from their customers and other business partners. In this regard, acquiring new Internet and Web-based technologies also implies investment in the training and organizational development required to assimilate and integrate these technologies successfully. While these investments may be quite large and induce major changes in business processes, they should contribute to the development of the SMEs that make them.

To the extent that small business managers want their firm to grow, the empirical evidence provided by this study leads one to conclude that they should look at the present level of e-business assimilation in conjunction with their strategic intent or growth-orientation. Identifying which applications such as e-commerce and e-collaboration are assimilated and which are not, and which are integrated and which are stand-alone, would be essential in determining to what extent the firm’s e-business use is aligned with its network environment, its strategy, its manufacturing environment and its manufacturing technology. For instance, this would help in answering a question for many SMEs, that is, if and when they must integrate their computer-integrated manufacturing or enterprise systems with their business partners’ systems or with the e-marketplaces developed by intermediaries or by large enterprises within certain industries such as the automotive and aeronautic industries (Brown and Lockett 2001; Kaplan and Sawhney 2000).

The results and implications of this study must be considered in light of the intrinsic limitations of survey
research. The nature and relatively small size of the sample limit the capacity to generalize research findings. The cross-sectional nature of the research design implies that true causal relationships between the research constructs cannot be inferred. Also, the breadth of e-business assimilation in manufacturing SMEs was measured but not its depth. Additional measures of growth and internationalization would have also given increased validity to the results.

CONCLUDING REMARKS

With the advent of global competition and new organizational forms based on networks of cooperating firms, the successful assimilation of e-business is bound to take added importance for many SMEs in terms of survival, growth and competitiveness. Given the dearth of empirical knowledge in this regard, the present study has contributed to a further understanding of the nature and state of e-business assimilation in small manufacturing firms, and of the antecedents and market development outcomes of this assimilation. It is recognized that these organizations are highly flexible and adaptable to change, be it environmental, organizational or technological. Some of these already possess advanced manufacturing systems and, in the new global business environment, must follow suit with Internet and Web-based information systems such as e-business intelligence, e-commerce and e-collaboration systems to improve their competitive position.

E-business investments cannot ensure greater performance unless they are coherent with the competitive environment, strategic goals and business processes of manufacturing SMEs. Results of this study imply that future research on the assimilation of e-business in these organizations must further explore the competitive dimensions of this phenomenon. In this regard, better explanations depend on furthering our knowledge of the level of alignment or ‘fit’ between the external (environmental uncertainties and pressures, networks) and internal (entrepreneur, strategy, structure, technology, culture) contexts in which e-business applications are introduced.

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References


