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Louis Raymond

François Bergeron

Sam Blili

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Louis Raymond[1], François Bergeron[2], Sam Blili[3]

[1] Département des sciences de la gestion, Université du Québec à Trois-Rivières, P.O. Box 500, Trois-Rivières, Québec, Canada, G9A 5H7 (louis_raymond@uqtr.ca)

[2] Groupe RGTI, Faculté des sciences de l'administration, Université Laval, Québec, Québec, Canada, G1K 7P4 (francois.bergeron@fsa.ulaval.ca)

[3] Institut de l'Entreprise, Université de Neuchâtel, CH-2000 Neuchâtel, Switzerland (sam.blili@unine.ch)

ABSTRACT

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?

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

1. 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 [1]. 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 adopting Internet-based or World Wide Web-based technologies as the infrastructure for e-business applications [2]. 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 [3].

The adoption and assimilation of information technology, and of the Internet in particular, are deemed to be influenced by a number of environmental, organizational, technological, and individual factors [4,5]. 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, given that their use of the Internet is usually more recent and potentially subjected to different constraints and contingencies related to their specificity as organizations. The specific characteristics that fundamentally distinguish SMEs from large enterprises relate to their environment, structure, strategy and decision process, and psycho-sociological context such as the dominant role of the owner-manager, but also relate to their flexibility, proximity to markets, and quickness to react and reorient themselves [6]. For instance, the fact that smaller manufacturers often act in a subcontracting capacity or in partnership with other firms within network enterprises can influence their assimilation of e-business [7]. Operating most often in "make-to-order" or "job-shop" production environments, rather than selling products as such to their customer, these firms "sell" their manufacturing knowledge and know-how within a particular industry (say, plastics) or industrial activity (say, machining). This makes for a more complex commercial cycle linking customers, suppliers, and other business partners [9].

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?

2. RESEARCH MODEL AND HYPOTHESES

Founded on the Tornatsky and Fleisher's [9] technology-organization-environment (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 organizational assimilation of e-business is conceptualized as the use of the Internet (including intranet and extranets) and the Web. The first business aim of 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 aims.

2.1 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 [10]. 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 centers and consultants.

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

2.2 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 [11]. 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 [6]. The strategic orientation of the SME must also be in alignment with its strategic management of information technology [12], including the Internet [13]. 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.

2.3 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 their owner-managers. 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 [14]. In this regard, small business studies have shown that the previously acquired knowledge and experience of business owner-managers condition their behavior as adopters of information technology [15]. In addition, a key component in the small firm's e-business learning experience is the owner-manager's individual learning [10]. 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 entrepreneur'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 firm's owner-manager experience and education, the greater its assimilation of e-business.

2.4 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 [16]. The flexibility required within a "make-to-order" production environment has led SMEs to adopt computer-integrated manufacturing [17]. 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 to better communicate and exchange information with their customers and suppliers [18]. 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.

2.5 Technological context of e-business in manufacturing SMEs

Advanced manufacturing technologies (AMT) are deemed to "significantly impact the design and outcomes of core organizational processes" [19, p. 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 [20]. 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 [3]. 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.

3. METHODOLOGY

The data used in the study were obtained from the PDG® database [21], containing information on more than 350 manufacturing SMEs located in Quebec, Canada. Out of these, 108 completed a questionnaire about their use of the Internet and the Web. The number of employees of the sampled organizations ranges from 19 to 336, with a median of 60. Over fifteen 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 [22]. As the key informant on the firm's strategic orientation, the 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 [23] and Julien and Raymond [24]. 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 [25]. Brandyberry *et al.*'s [19] classification is used to assess the firm's level of AMT assimilation: level 1) stand-alone AMT, level 2) functionally oriented AMT (CAM and FMS), and level 3) computer-integrated manufacturing. Growth is assessed by the average sales increase over the last three years whereas internationalization is measured by the mean percentage of sales turnover that has been generated via exports over the last two years.

The measure of e-business assimilation is based on a list of business activities 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 [26,27,28,29]. The extensiveness of each type of use is measured by counting the number of activities checked by the respondents.

4. RESULTS

The partial-least-squares (PLS) method was chosen to test the hypotheses. The criteria of unidimensionality, reliability and discriminant validity of the measures were considered to be met. 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 electronic 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.

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.

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 activity.

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 catalog-based buying and selling processes associated with "make-to-stock" production.

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 are SMEs in terms of their assimilation of advanced manufacturing technologies, the more they use the Internet and the Web for business intelligence purposes.

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.

5. CONCLUSION

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

Figure 1: Antecedents of e-business assimilation in manufacturing SMEs

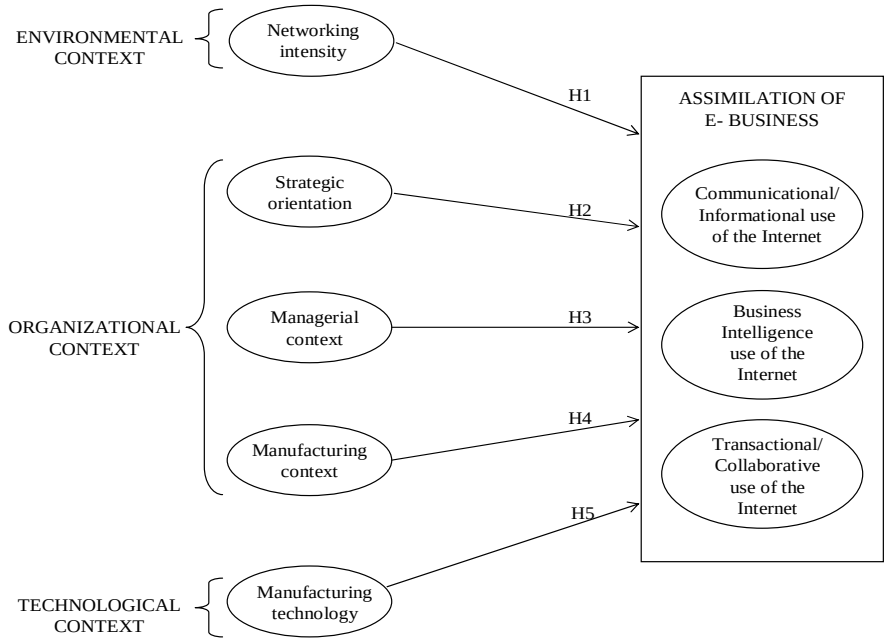
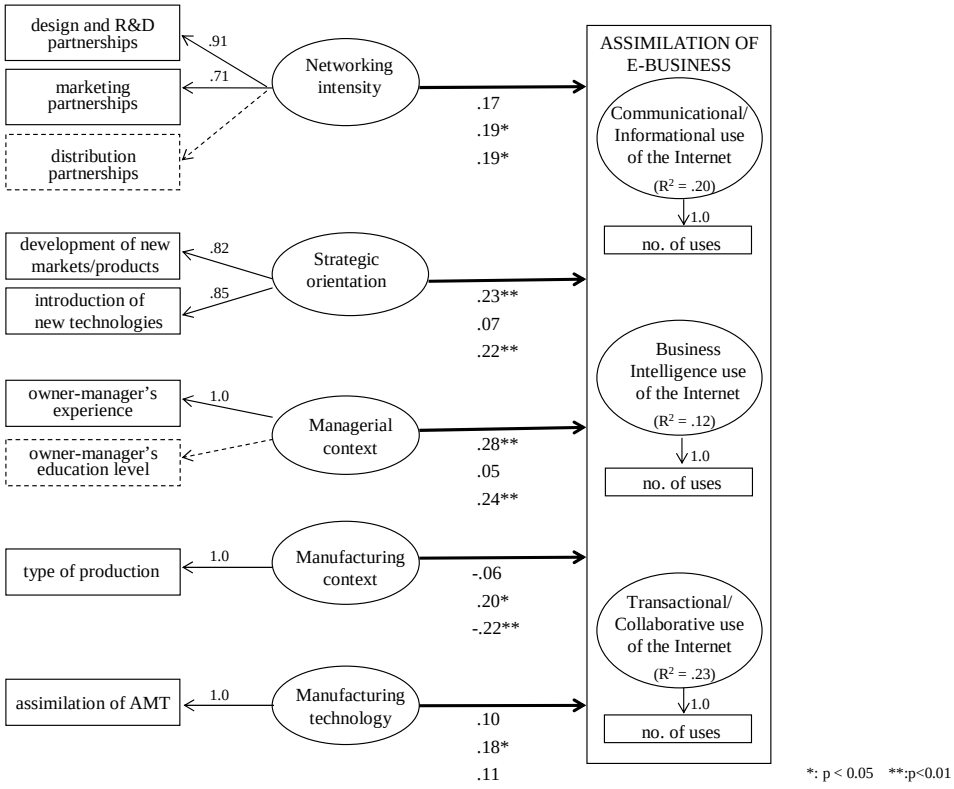


Figure 2: Results of the structural model analysis (PLS, n = 108)



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 now 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 insure 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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