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Knowledge, Technology and Innovation Cycle

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RESUMO/ABSTRACT

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There is a common thought both in business and academia that some factors such as technology, innovation and knowledge are key components of success and allowing firms to achieve and sustain competitive advantages. There is a considerable amount of research performed around these three concepts and some of them analyzed their relationship. However, it still suffers from oversimplification of its development processes and methodological limitations. Nevertheless, there is a consensus in business and academia that knowledge is a key component of success and allows firms to achieve and sustains competitive advantages. In a digital era, these advantages arise from the potential of data and information that can be gathered, processed, shared, and used to improve e-business activities. Thus, this research bridges the gap in the assessment of knowledge management and e-business relationship, by applying an SEM to a large database sample of KM activities performed by European firms.

Keywords: Knowledge management, information and communication technology, innovation, European and US firms.

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KNOWLEDGE, TECHNOLOGY AND INNOVATION CYCLE

Abstract

There is a common thought both in business and academia that some factors such as technology, innovation and knowledge are key components of success and allowing firms to achieve and sustain competitive advantages. There is a considerable amount of research performed around these three concepts and some of them analyzed their relationship. However, it still suffers from oversimplification of its development processes and methodological limitations. Nevertheless, there is a consensus in business and academia that knowledge is a key component of success and allows firms to achieve and sustains competitive advantages. In a digital era, these advantages arise from the potential of data and information that can be gathered, processed, shared, and used to improve e-business activities. Thus, this research bridges the gap in the assessment of knowledge management and e-business relationship, by applying an SEM to a large database sample of KM activities performed by European firms.

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Introduction

Efforts from current research have been made to determinate the role of information and communication technologies (ICTs) at the firm' level (Pilat 2004; Tiago et al. 2008).. From the different researches results that ICT impact is perceived as underline in: (i) the contribution of ICT investment to capital intensify; (ii) the contribution of TOE model on firm's performance; (iii) the spillovers of rapid innovation by the use of ICT; (iv) the competitive and dynamic effects of ICT on firms turbulence in terms of firm' entry, firm' exit, and the mobility of market shares of incumbents; and (v) the empower of strategic dimensions through the use of ICT tools.

One of the strategic dimensions is knowledge management, since companies need to use their skills to obtain the greatest competitive advantage (Spender, 1996). In creating and maintaining competitive advantages, organizations are developing efficient processes for managing knowledge (Liao, Fei, & Liu, 2008). In a period designated by some as "digital age" and by others as "knowledge age," the emphasis placed on business arises in the use of technology to maximize the application of knowledge (Soto-Acosta & Meroño-Cerdan, 2009; Zheng, Yang, & McLean, 2009).

Also, there are several studies that present a significant linkage between the generation, use and diffusion of knowledge and the ability of companies to successfully compete in highly innovative industries leading to question the traditional relation between knowledge and innovation. As Hill and Jones (1998) suggested, successful innovation of products or process gives a company something unique that its competitors lack. This is something that successful managers have known to be familiar long before the modern concepts of critical innovation, spin-off or entrepreneurial approaches. The findings made by the European Commission (Innobarometer) support this notion, since the inquiries state that the main reason for innovation activity is to build up the market share and ensure/increase the profitability of the company in order to protect the future independence of the company.

Knowledge, technology and innovation are three of the most quoted concepts as determinants of firms' success and the present study will cover this cycle assuming a combine perspective of the following scientific fields: information systems, management and marketing. Even not trying to do a fully coverage of all the knowledge

management history, concepts and applications, a brief acknowledge of its relevance over the years is present below. Although knowledge about the initial references to knowledge management dates back more than 2500 years Snowden (2000), this matter was the subject of interest, especially in philosophy and epistemology and only recently gained a prominent place in the organizational context. Since the 1980s, knowledge has been considered for organizational purposes as a "good/asset/capital" allowing the gaining valuable information and assuming the role of an irreplaceable resource, support strategies based on information management and innovation.

A wide range of knowledge systems has been presented (Boisot & Canals, 2004) advocate the partition of knowledge in itself, public, staff and common sense (Choo, Detlor, & Turnbull, 2000), based on the early work of Boisot, suggest a distinction between tacit knowledge, explicit and cultural turn (Blackler, 1995) underlines the existence of knowledge "embodied, embedded, embrained, encultured, and encoded," each considers the content and processes as launching platforms.

Looking at the evolution of knowledge management in historical terms, there are three generations of knowledge management. The first generation of knowledge management was from 1990 to 1995, when there were many attempts to define knowledge management and the potential benefits of this research for companies and the design of specific projects were emphasized (Nonaka, 1994; Wiig, 1993). At the same time, there was significant progress in artificial intelligence on knowledge management practices such as acquisition and storage of knowledge (Metaxiotis, Ergazakis, & Psarras, 2005).

The second generation of knowledge management began in 1996, and brought the emergence of new faces in knowledge management. This phase is also known for the adoption of multiple sources of knowledge management and the rapid integration of knowledge management practices in everyday organizational discourse. During this period, the research explored the definition of knowledge and corporate philosophies (Grant, 1996; McAdam & McCreedy, 1999), building systems (Alavi & Leidner, 1999; Lam, 2000), development of conceptual models (Chua & Goh, 2009; Holsapple & Singh, 2000b), defining operations and practices and integration of advanced technologies (Metaxiotis, et al., 2005).

While the second generation's emphasis is on changing the level of systemic organizational development, the third generation – new millennium - seems to emphasize the link between knowledge and action (Metaxiotis, et al., 2005) and presupposes that knowledge is inherently social, cultural and, as such, any organizational knowledge can only be achieved through changes in business and organizational practice.

When reviewing the existing concepts of knowledge, is evident that IT and information systems occupy a central position in relation to the dimensions of possession and knowledge creation, as well as the spread of knowledge and process management (Metaxiotis, et al., 2005).

One of the challenges it poses for organizations, as part of knowledge, is to acknowledge what each employee knows, such as applying the knowledge and what is his or her personal contribution to the generation and application of knowledge in the company. This is one of the challenges that can be overcome by the adoption of technology tools fostering the relationship and constant interaction among employees.

Modern technology facilitates the integration of dispersed knowledge, accelerates the replication of best practices, eliminates time and geographical constraints, and facilitates use and access by multiple users. However, controversy persists about the role that information technology should play in knowledge management. The positions are extreme: some overvalue and others underestimate it, requiring a balance in order to identify opportunities where IT can facilitate knowledge management practices (Wild & Griggs, 2008).

Wild and Griggs (2008) tried to understand the identification and classification of knowledge and the determination of its specific value to an organization, by assessing the sources of knowledge and application opportunities. These authors started from the concept that despite current IT infrastructure to allow the organization, formalization and distribution of organizational information, few are able to pass the stage of the generation, application and development of organizational knowledge. In this sense, these authors developed a three-dimensional model composed by the knowledge management life cycle, the knowledge management internal level and knowledge management targets to identify opportunities for IT.

According to Wiig (1993) knowledge management rests on three pillars, which are reflected in the ability to: (i) exploit knowledge and its appropriateness to context and organization, (ii) to estimate the benefits and value of knowledge, and (iii) actively manage knowledge. The author concludes that each of these pillars requires a range of knowledge associated with the use of methods, tools and technologies, and approaches to learning.

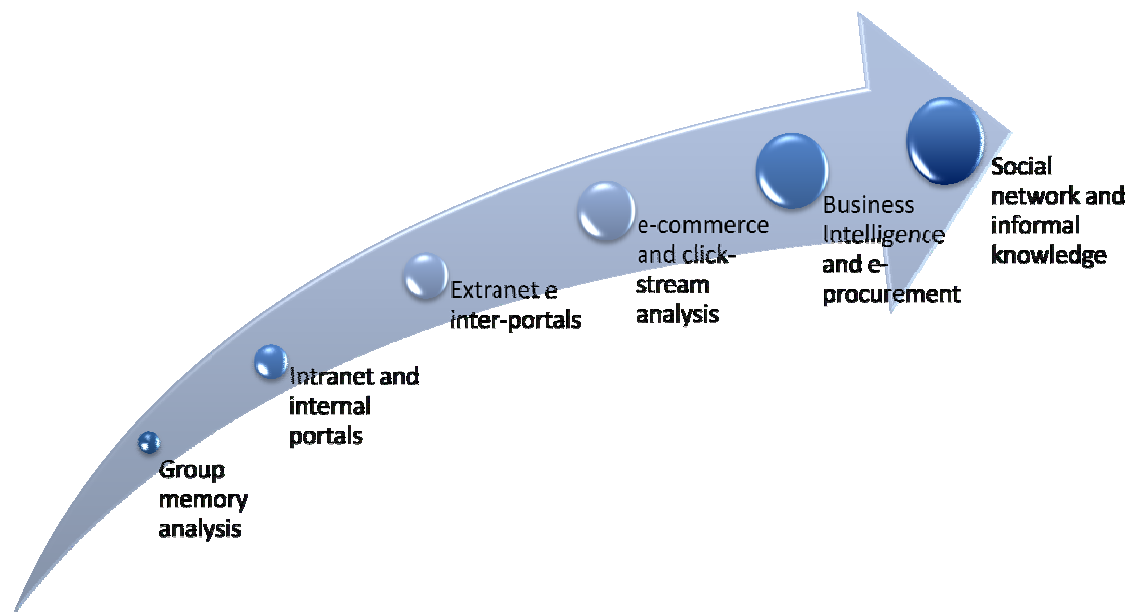
Some of the more recent work in this area has foreshadowed the importance of assessing not only the way it handles the lifecycle and level of knowledge management of the organization, but also how to integrate its goals into IT and global firm strategies (Cetindamar, Phaal, & Probert, 2009; Chen & Lin, 2009; Fan, Feng, Sun, & Ou, 2009; Hsieh, Lin, & Lin, 2009; Lehtimäki, Simula, & Salo, 2009; Zheng, et al., 2009).

According to Anderson, Hansen, Lowry, and Summers (2005), many companies that have adopted e-business, leveraged critical business processes, explored the Internet as a medium for transaction management, and allowed access to a wide range information, services and even remote access payment. However, is not totally clear the relation between the investments made in IT systems and organizational performance. There are authors, such as the IT-economist Paul Strassmann, suggesting that no correlation can be assessed between computer expenditures and company performance. Others conclude that the investments made in information systems can generate different competitive advantages. More recently, Valacich and Schneider (2010) considered that e-business in the digital network enhances four components: (i) the inputs of the business, whether they take on characteristics of raw materials or other information, (ii) resources, both human and capital, (iii) the practices of e-commerce, and (iv) management and analysis of processes taking as a tool to support customer feedback. As virtual business management evolved, knowledge gained relevance in the context of the management as science and a means of supporting strategic definition (Tsoukas, 1996).

As described in Oppong, Yen, and Merhout (2005) knowledge management has become a valuable asset for organizations with the awareness of the potential information on the environment.

From the perspective of management initiative, knowledge management has adopted a set of technologies and takes advantages of inbreeding processes, such as innovation to increase the application and use of information and to move forward from an era base on information competitive advantages' creation to one base on knowledge development. Some of the digital age's influences on the evolution of knowledge management are depicted in the following figure, where some knowledge base ICT most common features are listed.

Figure 1 – Digital era's impact on evolution of knowledge management



Source: Adapted from Kalakota and Robinson (2000)

The development depicted in Looking at the evolution of knowledge management in historical terms, there are three generations of knowledge management. The first generation of knowledge management was from 1990 to 1995, when there were many attempts to define knowledge management and the potential benefits of this research for companies and the design of specific projects were emphasized (Nonaka, 1994; Wiig, 1993). At the same time, there was significant progress in artificial intelligence on knowledge management practices such as acquisition and storage of knowledge (Metaxiotis, Ergazakis, & Psarras, 2005).

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Figure 1 occurred in the last 20 years and justifies the importance of knowledge management in leveraging e-business performance. Gottschalk (2007) suggests an integration of IT and knowledge management that has evolved and occurs at four different stages: end user tools; who knows what; what they know and how they thing. To this author most firms nowadays can now found on the first two phases.

Unlike most conceptions proposed in information systems research and trade press, Malhotra (2000) presented a conceptual model base on the notion that KM gathers the critical issues embodies in organizational process, supporting a synergistic arrangement of data and information-processing capacity of information technology, and innovative capability. According to this author innovation and creativity are needed to renewal organization knowledge repositories and information technologies are consider as support features to organizational processes.

Back in 2000, Malhotra suggested that regardless of significant progress in technologies and large investments done in knowledge-driven technologies, firms were trying to find answers to simple questions such as: *how to capture, store and transfer knowledge? How to ensure that knowledge is being transfer among employees?* This still is an ongoing quest and some organizations, instead of acquiring highly complex and sophisticated IT systems that support the KM, explore the components of the knowledge

management cycle through the use of existent ICT features. Thus, this will be the starting point of the research model that will be presented in the next section.

Evaluation Framework and Hypotheses

The digital era presents enormous challenges, especially if firms consider the gathering of information about customers, suppliers, markets, and supply, and the easy processing of information about company processes, products, and services. However, firms seem to realize that in most scenarios, the scarce resource is not information, but the proper use of knowledge.

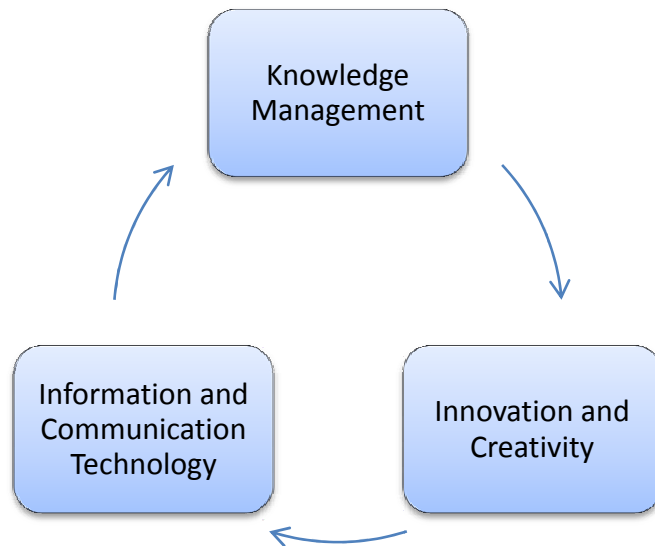
Literature review showed evidence that organizations tend to change to meet the increasing competitiveness of global markets, applying new business models and more innovative practices (Strauss, El-Ansary, & Frost, 2003; Wu, Ong, & Hsu, 2008).

As stated in the literature, most studies indicate an effect of knowledge as a component and driver of innovation. But in the current context in which the technologies are assumed as elements of performance enhancers at various organizational levels, innovation emerges also as a generator of knowledge, whether it be considered radical or incremental innovations (Tajeddine, 2009). This new approach, still somewhat embryonic, is the path follow in this working, since innovation will be analyse as a driver of ICT adoption and use. Thus, innovation is expected to have a direct positive impact on ICT adoption and positive indirect impacts on KM and e-business performance.

The work of Eder and Igarria (2001) analyses the impact of ICT on business performance and stressed that there are some indirect effects which need to be consider. More recently, Bayo-Moriones and Lera-López (2007) suggested that the positive impacts identified are not limited to increased productivity and reduced costs, influencing intermediate performance measures such as process efficiency, quality of services, organizational improvements, knowledge flows and customer satisfaction. Thus, it seems important to confirm Malhotra (2000) model path regarding ICT influence on KM practices.

In order to address these issues, the present study analyzes the developments and definitions of knowledge management and based on the Malhotra (2000) models puts forward a conceptual model that integrates innovation and ICT impact on knowledge management activities.

Figure 2 – Conceptual Model



The components that integrate knowledge management activities are not based on an IT knowledge management system, but combine all processes identified inside the firms that contribute to the gathering, processing and sharing of data, information and knowledge through all firm stakeholders.

For that purpose we use a structural equation model with latent variables, which consists of two sub models: the measurement model and the structural equation model. The former shows how the latent variables or factors are measured and the latter indicates the relationships among the latent variables. The validation of the measurement model is done by using Confirmatory Factor Analysis (CFA). We will see later that the observable variables (indicators) we selected are measures of latent variables (factors). We assume that innovation and ICT features have a direct effect on knowledge management. Therefore, we assume that knowledge management strategy can be explained by ICT practices and innovation components.

As described in Metaxiotis et al. (2005), during the last twenty years, knowledge management has undergone generational leaps through constant improvements and new perspectives. Malhotra (2000) suggested a direct impact of innovation and creativity in

KM. Nevertheless, during the development process of innovation there is acquisition, processing and sharing of knowledge pre-existing or entirely new (Damanpour & Daniel Wischnevsky, 2006). Also the research of Gulati et al. (2006) identifies the technological advances that have occurred over the last decade as a reflection of the incorporation and adoption of innovations ranging from the incorporation of nano technology until adoption of wireless systems. Hence, the foregoing discussion suggests that: **H1: Innovation practices have a positive impact on adoption of information technology and communication.**

For Gottschalk (2007), the development and acceptance of technology, diffusion of innovation and organizational learning processes can justify the different models and stages of adoption of knowledge management in organizations. Metaxiotis et al. (2005) suggested that technologies may be promoters of the incremental process of development and sharing of knowledge repositories. This led to the second hypothesis: **H2: The adoption of information communication technology has a positive impact on knowledge management.**

The model of knowledge management presented by Tiwana (2001) and optimized for technological contexts by Kwan and Cheung (2006) assumes that knowledge management operates in a cyclical mode within the organization and is composed by three interconnected dimensions: acquisition, application or processing and knowledge sharing. Some of these components seem critical to the proper creative and innovative process. Thus, the third hypothesis defines KM as the integration of the three dimensions consider in Tiwana' model and is written as follows: **H3: Knowledge management activities have a positive in creative and innovative process.**

Accordingly, the first hypothesis sought to identify a positive impact on innovation processes, as an agent driving the adoption and use of ICTs. The second hypothesis seeks to confirm the inference that there is a positive impact of ICTs on knowledge management.

The third hypothesis measures the impact of the global process of knowledge management in creativity and innovative process.

Therefore, and considering the literature review done in this study, the previous hypotheses were established in order to understand which factors have influence on

KM. The methodology used throughout this empirical work is described in the next chapter.

Methodology and Results

To validate these assumptions, data was collected from a sample of 2.248 European and American firms from two services industries and covering seven dimensions of analysis: (1) ICT infrastructure and e-business software systems; (2) automated data exchange; (3) e-standards and interoperability issues; (4) Innovation activity of the company; (5) ICT skills requirements and ICT costs; (6) ICT impacts, drivers and inhibitors; and (7) background information about the company. The decision to adopt Europe and North America as a field of study came from the limited amount of comparative research on knowledge management on the internet (Zhu, Kraemer, & Dedrick, 2004). The data employed in the empirical research comes from e-Business W@tch annual survey (2007), covering eight countries: the USA, Poland, France, Germany, Spain, Sweden, the UK and Italy.

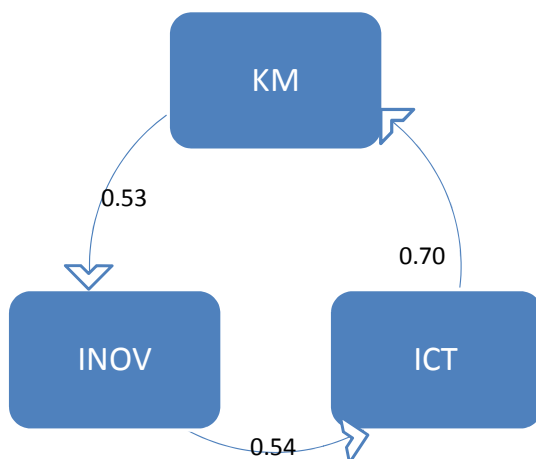
Initially we used a set of descriptive statistics that allowed for a greater sensitivity to the data (Sekaran, 2006). Such descriptive statistics also acted as guide for the multivariate statistics (Hair, Anderson, Tatham, & Black, 1998). Some notes about the sample used. Around 54.4% of the firms were small or micro-sized. Some authors have noted that the size of the company constrains online activities (Dewett & Jones, 2001). In contrast, some studies have reported that, in terms of digital environments, the differences in the size of organizations do not make sense. This lead to questioning firms about their perception of firm' size influence on e-business activities. Only the Polish respondents consider firms' size as a relevant restraining factor of e-business activities.

As it seeks to share and disseminate information and knowledge, digital security emerges as a relevant aspect to consider in knowledge management in virtual environments. For that reason, it has drawn attention from both businesses and academic researchers. Thus, respondents were asked about the importance of security and privacy in the development of e-business activities. USA firms expressed the most concerns with security and privacy, closely followed by German and French firms.

One of the points made in the valuation model of technological sophistication of Colecchia and Schreyer (2002) is the way it handles the transmission of information within and between firms. The results suggest that recourse to the use of electronic transmission as the main medium has its greatest expression in Sweden and the UK, When measuring combine electronic and paper source transmission of information greater expression was found in the United States of America and Germany firms. These two countries are those in which the use of traditional media (verbal and paper) does not correspond to more than 50% of the processes of information transmission.

An inspection of the informal practices of the knowledge management cycle in these companies is apparent the following figure.

Figure 3 – Informal KM cycle activities



The model was estimated by the maximum likelihood method in the AMOS package. The model goodness of fit may be considered acceptable according to the values

of some goodness-of-fit indexes, although the chi-square test statistic ($\chi^2 = 1586,418$; p-value = 0,000) is significant, implying a bad fit. However, this test is known to have serious limitations — namely its dependence on the sample size and on the number of indicators. In general, for large sample sizes the chi-square statistic is significant, and in

the present case the sample size is very large. Several goodness-of-fit tests were conducted to assess whether the empirical model could explain the observed data. The measures for global model fit (below) suggest that our model fits the underlying data quite well and that the hypothesis paths were all statistically significant.

After global model fit has been assessed, the numerical results were evaluated to test their support of the research question. The numerical results can be obtained directly from the path coefficients of the structural model (**Erro! Auto-referência de marcador inválida.**).

Figure 4 - Structural equation model and estimation results

Index	Value for the model	Reference value (Hair et al. 1998)
p-value	0,000	p > 0.05
RMSEA	0,043	< 0.05
NFI	0,820	> 0.8
TLI	0,811	> 0.8
CFI	0,848	> 0.8

Our findings support the conceptual framework regarding to all hypotheses. Thus, this finding lends empirical support to the concept that e-business activities can be improved by exploring the information knowledge management. Similarly, gathering, processing and sharing contribute 99%, 74% and 89% to the knowledge management construct, respectively. The significant relationship achieved between Innovation and ICT (0,54) and the positive direct impact of ICT in KM (0,870) supports the idea that a non traditional knowledge management system can be adopted by integrating innovation practices, concepts and processes, and technological tools. Thus, besides its influence in the innovation process (0,53), it must be consider the mutual influence of the components.

A split structural equation model was also performed to analyze the possible difference among regions, especially Europe and North America. Nevertheless, the model achieved was not reliable and for that reason no remarks can be presented.

Conclusion

As Malhotra (2000) suggested, little empirical evidence supports the direct correlation between IT investments and organizational performance or firms' own knowledge management. However, the success of organizations depends on and can be optimized by the way in which employees use the knowledge in the processes of value creation. Thus, it is important to answer to question: how do organizations take advantage of knowledge management by integrating new technology tools and innovations to improve their business activities?

The literature review showed that only a few works have taken a corporate perspective to examine the contributions of knowledge management to e-business performance. However, most of these works were confined to specific industries or countries. The analysis of the adoption and use of informal knowledge management processes inside firms is even slighter. Therefore, the goals of this study were therefore: (1) to determine whether the implementation of ICT and innovation is positively linked to knowledge management; (2) to determine which of the components of the knowledge management cycle have more impact; and (3) to identify the nature of the relationship between knowledge management and innovation.

The main results suggest a strong positive relationship between knowledge management and innovation process as well as a positive impact of ICT and innovation process on the knowledge management cycle. The analysis also reveals that in digital environments the gathering and sharing of activities has a greater impact on global knowledge management than processing activities do. The analysis reveals that no relationship can be established between a firm's practices and its country of origin.

This work contributes to the theory of knowledge management by considering ICT tools as drivers for knowledge management processes and the mutual influence of KM and innovation, applied to the European and American realities. However, these findings should be viewed in light of some limitations. Further work is clearly needed to examine the inclusion of news elements such as management support to knowledge management initiatives and multi-level analysis of e-business process. Aside from these considerations, it would be interesting to compare the results of online to those of brick-and-mortar firms. Certainly, there is ample scope for further research in this area.

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