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Industry clockspeed's impact on business innovation success factors

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Abstract

Purpose – The literature prescribing important determinants of innovation success is grouped into four main areas encompassing strategic leadership, competitive intelligence, management of technology, and specific characteristics of the company's innovation process. Further, industry clockspeed has been considered to be a possible moderator for these determinants of innovation success. While these major areas of study may indeed be important to enhance company innovation and competitiveness, the existing literature on each area is not being shared by researchers in the other areas. That has led until now to the study of models relatively narrow in scope and primarily focused on the particular research area. This study aims to test these constructs as a set of determinants of innovation success and the possible moderating effect of industry clockspeed.

Design/methodology/approach – A field test using a mailed questionnaire to collect a relatively large sample has been used to test the proposed model. To eliminate possible multicollinearity among the independent variables, a multivariate regression analysis was used.

Findings – The results provide clear evidence about the importance of industry clockspeed as a moderator of the relationships between strategic leadership, competitive intelligence, management of technology, and specific characteristics of the company's innovation process with company success in business innovation. Also, the company's change process as defined here is equally important to low and high clockspeed industries for successfully implementing business innovations.

Research limitation/implications – Despite the relatively broad scope of the proposed model, other factors may also be important and should be included in future studies.

Practical implications – The items used for measuring the main constructs provide further and more specific insights into how managers should go about developing these areas within their organizations.

Originality/value – While the study is grounded in the literature of what until now have been four separate areas of knowledge, it proposed an integrated model for these areas important to business innovation, and empirically tested the model.

Keywords Business innovation success, Competitive intelligence, Strategic leadership, Management of technology, Innovation process, Industry clockspeed, Competitive strategy

Paper type Research paper

1. Introduction

While many organizations have derived substantial benefits from business innovation, success implementing the required changes is far from assured, with many organizations also reporting disappointing results due to missed objectives, unexpectedly high costs, and turmoil caused by the changes. Besides the continuous need for organizations to re-invent themselves and for developing new products and services (O'Sullivan, 2003), over the past decade the main emphasis worldwide has been on improving quality. To satisfy their need for innovation, many companies have adopted total quality management (TQM) or similar quality improvement

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methodologies that call for a continuous effort to improve products, processes, and operations to better satisfy customer needs. The required changes may also call for employee empowerment in decision making, a team approach to identify, prioritize targets for improvement, including changes to organization values and culture. Although there has been a significant amount of success with TQM, managers have realized that in many cases there is need for more dramatic improvements in productivity, competitiveness and profitability. This can be accomplished by major paradigm shifts which focus on value-added activities as well as other underpinnings for successfully implementing the concept of business process reengineering (BPR) (Goll and Cordovano, 1993; Teng *et al.*, 1994; Caccia-Bava *et al.*, 2005).

Regardless of the change methodology being employed, the factors important to innovation success or failure are many, but most authors would agree that the change process has to bear certain characteristics. Many researchers have looked to improvements in strategic leadership as critical to developing an organization environment conducive to innovation (Waldman *et al.*, 2001; Williams, 2004). To help define and prioritize important problems and opportunities to the organization, many have proposed competitive intelligence (CI) programs as important to company success (Guimaraes and Armstrong, 1998a; Vedder and Guynes, 2002; du Toit, 2003; Tarraf and Molz, 2006). Further, effective management of technology (MOT) is thought to be a critical requirement for successfully implementing most modern business changes (Beattie and Fleck, 2005). While these propositions are exceedingly important, the existing literature contains little empirical evidence supporting them. As called for in the study by Guimaraes and Armstrong (1998a), while these constructs are well established among scattered groups of academic researchers and practitioners, much can be done to empirically test these propositions. Some of these constructs have been addressed by narrow groups of academic researchers and almost completely ignored by others studying the management of innovation, despite their importance among practicing managers. For example, despite its critical importance for organization innovativeness and absorptive capacity, strategic leadership has been substantially ignored by the academic circles researching the management of technology and innovation. Even more surprising has been the academic researcher community's neglect of CI as an important determinant of business innovation success, at a time when large numbers of managers from many companies have formed a professional association and created a special journal to specifically address issues important to this area. Similarly, some researchers of business innovation have addressed special characteristics of the innovation process as an important factor for implementation success, but many other researchers of innovation management have ignored this construct altogether. Last, despite the increasing acceptance of industry clockspeed as a potentially important influence on the need to innovate, as well as on the entire process of business innovation, very little empirical research is available addressing clockspeed as a factor in business innovation success (Carrillo, 2005; Meijboom *et al.*, 2007; Nadkarni and Narayanan, 2007; Weijermars, 2009). Thus, it might be particularly important to academic researchers and practicing managers alike to test an integrated model which brings together these major factors potentially important to effective implementation of business innovation. That was the primary objective of the field test discussed here.

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2. Theoretical background and proposed hypotheses

2.1 Dependent variable – business innovation success

Business innovation has been studied from a very wide variety of perspectives. Enkel *et al.* (2009), among many others, have explored the importance of innovation approaches that emphasize the inclusion of company outsiders. Johannessen *et al.* (2001) provided some guidelines for categorizing types of innovations in terms of what is being changed, how new, and new to whom? While it is important to understand the great variety of perspectives and factors affecting business innovation, this study has a very specific practical focus: The literature prescribing important determinants of business innovation success is grouped into four main areas encompassing strategic leadership, competitive intelligence, management of technology, and specific characteristics of the company's innovation process. Further, industry clockspeed has been considered to be a possible moderator for these determinants of innovation success. While these major areas of study may indeed be important to enhance company innovation and competitiveness, the existing literature on each area is not being shared by researchers in the other areas. That has led until now to the study of models relatively narrow in scope and primarily focused on the particular research area. This study proposes an integrated model that tests these constructs as a set of determinants of innovation success and the possible moderating effect of industry clockspeed. To accomplish that, this study uses a broad definition of business innovation, without specifically measuring details of the innovation process such as if partners were involved, if it created new markets or new sources of supplies, etc.

The rationale for the definition/measure of innovation used here starts with the premise that to derive benefits from strategic opportunities and address problems, companies have to implement innovations to their business processes, products, and/or to the organization itself. This variable represents the degree of company effectiveness in implementing business innovation in these areas. A company's ability to effectively implement these innovations has a dramatic impact on organization performance and business success (Guimaraes and Armstrong, 1998a). A survey of the practitioner and academic literatures shows that to manage business innovation effectively organizations need to:

- be in touch with their markets, customers, competitors, new products, etc.;
- have adaptive leadership which promotes innovation;
- manage technology effectively in supporting the necessary changes; and
- follow some basic prescriptions while implementing the innovation process.

Each one of these is correspondingly represented by the independent variables in this study which are discussed next.

2.2 Independent variable – CI

To keep in touch with what is going on in their markets, managers are increasingly recognizing the importance of competitive intelligence and knowledge management as a key asset (Darling, 1996; Vedder and Guynes, 2002; du Toit, 2003; *The Information Management Journal*, 2005; Tarraf and Molz, 2006). With the increase in business competition, company survival and success is now determined by its rate of learning. If it is faster than external changes, the organization will experience long-term success

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(Darling, 1996). Ironically, even though as much as 68 percent of US companies have an organized approach to providing information to decision makers (Westervelt, 1996), according to Ettorre (1995), probably less than 10 percent of American corporations manage the CI process well, and effectively integrate the information into their strategic plans. The antecedents and consequences of CI dissemination have been studied by Maltz and Kohli (1996). Competitor analysis (CA) was proposed by Ghoshal and Westney (1991), and other approaches useful for companies to collect information from competitors were addressed by Heil and Robertson (1991). The importance of organization intelligence to financial performance has also been demonstrated. Companies with well established CI programs on the average showed earnings per share of $1.24, compared with those without CI programs that lost seven cents (King, 1997).

The literature contains many examples of benefits that can be derived from CI. Among these are improved competitive edge (McCune, 1996; Sawka, 1996; Westervelt, 1996; du Toit, 2003; Editors, 2004) and improved overall company performance (Babbar and Rai, 1993; Guimaraes and Armstrong, 1998a; Davison, 2001), two essential company goals that can be brought about with effective application of competitive intelligence. More specific benefits of CI include: uncovering business opportunities and problems that will enable proactive strategies (Ellis, 1993; Westervelt, 1996); providing the basis for continuous improvement (Babbar and Rai, 1993); shedding light on competitor strategies (Harkleroad, 1993; Westervelt, 1996); improving speed to markets and supporting rapid globalization (Baatz, 1994; Ettorre, 1995); improving the likelihood of company survival (Westervelt, 1996); increasing business volume (Darling, 1996); providing better customer assessment (Darling, 1996); and aiding in the understanding of external influences (Sawka, 1996). Benefits such as these provide the basis for firms to better understand the potential impact of the proposed innovations and the means by which they can be infused into the company's fabric. Based on the above discussion, we propose the following hypothesis:

H1. Company CI effectiveness is directly related to effectiveness implementing business innovation.

2.3 Independent variable – strategic leadership

There is a substantial body of knowledge proposing the importance of effective leadership as an ingredient to successful organization innovation (Waldman *et al.*, 2001). There are many types of leadership (i.e. formal/informal, based on specific skills, social status, etc.) arising from the circumstances in which leaders/followers find themselves. However, for the purpose of this study the relevant construct is company strategic leadership. Pawar and Eastman (1997) proposed transactional strategic leadership as one operational within an existing organizational system or culture instead of trying to change it. It attempts to satisfy the current needs of followers by focusing on exchanges and contingent reward behavior. It pays close attention to exceptions or irregularities and takes action to make corrections (Burns, 1978; Bass, 1985). Conceptually similar to the cultural maintenance form of leadership described by Trice and Beyer (1993), transactional leadership acts to strengthen existing organization processes, structures, strategies, and culture.

The second form of strategic leadership is transformational or "charismatic" leadership (Pawar and Eastman, 1997). According to Waldman *et al.* (2001, p. 135) the leader articulates "a vision and sense of mission, showing determination, and

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communicating high performance expectations". The followers reply with confidence in the leader and strong admiration or respect. Also they identify with the leader's vision and with the organization itself, creating a high level of collective cohesion. This cohesion and the leader's expressions of confidence in the followers' ability to attain the vision produce, in turn, a heightened sense of self-efficacy (Podsakoff *et al.*, 1990). Further, charismatic leaders are likely to show persistence and enthusiasm in pursuing goals and be demanding of others through the communication of high performance expectations (Kanter, 1983; Trice and Beyer, 1993). There is evidence that charismatic leadership at the top executive level is important for company performance (Hambrick and Finkelstein, 1987; Day and Lord, 1988; Yukl, 1998). Katz and Kahn (1978) argued that while charismatic leadership may be more relevant to situations where organization innovation is important, both transactional and transformational (charismatic) leadership are potentially important at the strategic level, that it is particularly important as a means of mobilizing an organization to meet the demands of its environment. Bass (1985) viewed transactional and charismatic leadership as being somewhat complementary in that both could be displayed by the same individual leader. Similarly, Trice and Beyer (1993) acknowledged that both maintenance- and innovation-oriented leadership could be shown by a given leader over time. Based on the above discussion we propose the following hypothesis:

> *H2*. Strategic leadership is directly related to effectiveness implementing business innovation.

2.4 Independent variable – MOT supporting business innovation

As business competitiveness increases, many business organizations have used technology for redesigning business processes, provide new products and services, and improve the organization work environment. Many authors have proposed the importance of a wide variety of technologies to support business innovation (Khalil and Ezzat, 2005; Li-Hua and Khalil, 2006). Computer Telephony Integration has been touted as a powerful tool to improve the relationship with customers (McCarthy, 1996). The effects of computer technology on organization design, intelligence and decision making have long been of interest to researchers (Huber, 1990). The use of computers for data mining and warehousing is seen as essential for decision support (*Software Quarterly*, 1995). Friedenberg and Rice (1994) and Guimaraes *et al.* (1997) have proposed expert systems as viable implementation vehicles for business change because they are effective in capturing and distributing knowledge and knowledge processing capability across an organization. The list of technologies available to support the necessary business innovations is endless. For business innovations requiring technology, without effective MOT the innovation implementation processes would be severely hindered and in many cases rendered impossible. Based on the above discussion, we propose the following hypothesis:

> *H3*. MOT effectiveness is directly related to effectiveness implementing business innovation.

2.5 Independent variable – important characteristics of the innovation process

A survey of the literature on business innovation management reveals several prerequisites for successfully implementing business innovation such as conformity to

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company objectives, employee and department participation in the innovation process, customer input, reasonably balancing risk taking with cost benefit analysis, monitoring progress, and communication regarding the innovation process. In other words, how innovation is implemented is an important determinant of success. Specifically, as proposed by Guimaraes and Armstrong (1998b), the important characteristics of the innovation process enumerated above are expected to influence the company's ability to successfully change its products, processes, and its organizational structure and culture. Thus, we propose the following hypothesis:

H4. The extent to which the innovation process bears the desirable characteristics will be directly related to company effectiveness implementing business innovation.

2.6 Moderating variable – industry clockspeed

Some authors have addressed the issues of managing product innovations in a high velocity environment (Brown and Eisenhardt, 1997; Souza *et al.*, 2004; Carrillo, 2005). According to some authors, industry clockspeed is an important factor in assessing company management strategies (Nadkarni and Narayanan, 2007; O'Connor *et al.*, 2008; Weijermars, 2009). The term "clockspeed" refers specifically to a composite measure of the rate of change along a number of dimensions exhibited by companies within different sectors of the economy (Fine, 1998). The dimensions of clockspeed fall into three groups referring to the rate of change in products, process and organizational factors. The swifter the rate of change is, the higher the clockspeed. The mining industries provide examples of slow-clockspeed industry sector, and the computer software industry is an example of a fast-clockspeed sector (Fine, 1998). There is some controversy as Perrons and Platts (2005) found that industrial clockspeed does not seem to play a significant role in the success or failure of a particular outsourcing strategy for a radical innovation. On the other hand, Noke *et al.* (2008) provided case study (oil and gas company) evidence that strategic dalliances can be an enabler for the discontinuous innovation process in slow clockspeed industries.

Clockspeed is likely to be important to the study of innovation management because it may act as a moderating variable for the relationships between the independent variables and the dependent variables studied here. Some authors have conjectured about a positive relationship between the use of technology and the degree of business environment uncertainty characterizing a particular industry sector (Bensaou and Venkatraman, 1995; Nadkarni and Narayanan, 2007; Weijermars, 2009). Mendelson and Pillai (1998) found a positive relationship between industry clockspeed and the effective use of technology by firms. A high clockspeed environment requires the ability to effectively react to swiftly changing business conditions thus exacerbating the importance of the independent variables being studied. In general, quickly changing business environments create more uncertainty and place considerably more strain on direct human relationships than slower business environments (Bensaou, 1997; Hall, 1999) thus requiring greater leadership, more knowledge about business conditions, and better management in general. In a relatively stable industrial environment, there is less need for innovation and less need for managers to quickly identify business problems and opportunities, find technologies and other resources necessary for innovation, and spend time and energy managing innovation (Handfield

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et al., 2000). Based on the above discussion, we propose the following hypotheses (see also Figure 1):

H1b. High clockspeed heightens the relationship between competitive intelligence and innovation success.

H2b. High clockspeed heightens the relationship between strategic leadership and innovation success.

H3b. High clockspeed heightens the relationship between effective MOT and innovation success.

H4b. High clockspeed heightens the relationship between the extent to which the innovation process bears the desirable characteristics and innovation success.

3. Study methodology

This section provides an overview of the field-test data collection procedure, a brief description of the sample demographics, a detailed discussion of how the variables were measured, and the data analysis procedures.

3.1 Data collection procedure

This field test used a mailed questionnaire to collect data from the internal auditor (IA) director of each company. IAs were chosen as respondents because, from a corporate perspective, they are most aware of the problems and activities throughout the company. Furthermore, the group is relatively homogeneous, a characteristic that strengthens internal validity of the data collection instrument used in the study. We

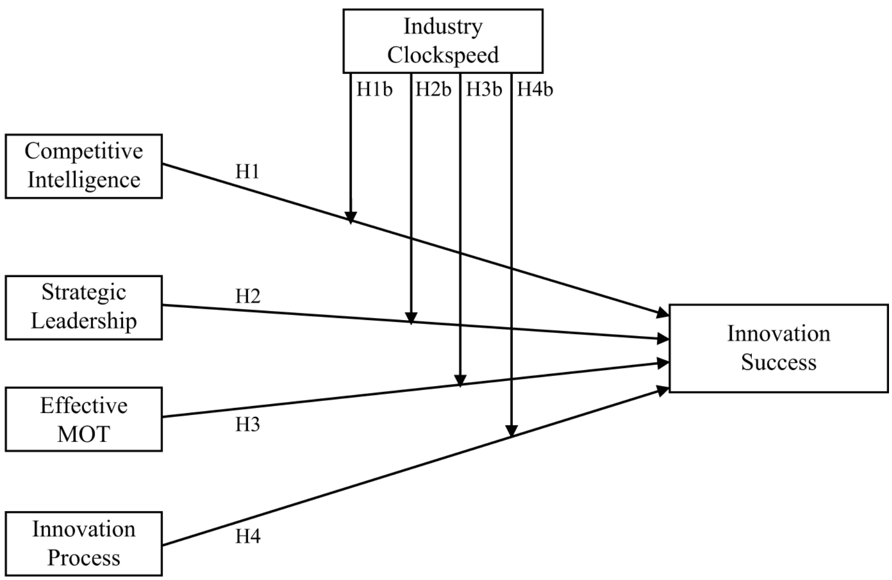

Figure 1.
Theoretical model

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felt that a survey of top managers who are directly responsible for strategic leadership, or of managers directly involved with specific projects implementing organizational innovations, would have greater likelihood of bias. After some rewording of a few questions following the input from a small pilot test involving four IAs, the questionnaire was distributed by mail to the IAs of 1,000 organizations randomly selected from a list of approximately 4,000 members of an Internal Auditors Association. The sample represents a wide variety of organizational settings, (i.e. small as well as large companies), from several industry sectors. Participation was voluntary, and the cover letter assured confidentiality of the responses and that only summary information from the participants would be published. The survey was accompanied by a published report from a previous study on the topic (as a courtesy to prospective respondents) and by a postage-paid envelope addressed for direct return to the researchers.

3.2 Sample description

Through the procedure just described, 1,000 IAs were selected to participate in the study and 294 returned the questionnaire in time for data analysis. Nine questionnaires were thrown out due to missing data. The remaining 285 usable questionnaires provide a response rate that is acceptable for studies of this type (Teo and King, 1996) and consistent with past experience with mailed surveys (George and Barksdale, 1974; Igbaria *et al.*, 1991). Nevertheless care was taken to assess the representativeness of the sample. Chi-square tests were used with a sample of non-respondents to check for the possibility of non-response bias. The results of this test support the conclusion that based on company size (gross revenues) and industry sectors the companies in the sample are similar to those in the target sample. The actual sample versus the target sample percentage compositions in terms of primary industry sectors and company gross revenues are presented in Tables I and II, respectively.

Industry sectors	No. of companies	Actual sample[a] (%)	Target sample[b] (%)
Manufacturing	93	32.6	34.1
Financial Services	24	8.4	8.1
Banking	21	7.4	6.8
Other	21	7.4	6.6
Retailers	19	6.7	5.2
Health Care	18	6.3	5.1
Merchandising	16	5.6	6.5
Transportation	15	5.3	7.2
Utilities	15	5.3	4.7
Communications	13	4.6	4.9
Wholesalers	12	4.2	3.7
Insurance	10	3.5	5.1
Mining	8	2.7	2.0
Total	285	100	100

Notes: [a]$n = 285$; [b]$n = 1{,}000$

Table I.
Company industry sectors

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Table II.
Company gross revenues

Gross revenues ($)	No. of companies	Actual sample[a] (%)	Target sample[b] (%)
Less than 100 million	0	0.0	0.0
101 million-300 million	4	1.4	1.9
301 million-500 million	8	2.8	3.2
501 million-700 million	21	7.4	8.5
701 million-1 billion	31	10.9	9.7
1 billion-2 billion	43	15.1	13.3
2 billion-5 billion	49	17.2	16.8
5 billion-10 billion	72	25.2	28.0
Over 10 billion	57	20.0	18.6
Total	285	100.0	100.0

Notes: [a]$n = 285$; [b]$n = 1{,}000$

3.3 Variable measurement

Innovation success or company effectiveness implementing business innovation represents the company's ability to alter its business practices in the desired manner. As previously used by Guimaraes and Armstrong (1998a) and Guimaraes *et al.* (1999), this was measured by the respondents rating the effectiveness of the firm in changing four areas to address strategic problems and opportunities: products, processes, organization structure and organization culture. This was done in comparison with the closest competing organizations and using a seven-point Likert-type scale ranging from 1 extremely lower than average), 2 much lower), 3 somewhat lower), 4 average), 5 somewhat higher than average), 6 much higher), and 7 extremely higher). The ratings for the four areas were averaged to produce a single measure for effectiveness in implementing business innovation.

Strategic leadership represents the ability of the top management team to provide leadership when the organizational environment requires innovation. Environments perceived as highly uncertain (requiring major innovations) tend to be perceived as risky, where wrong decisions could be costly. Such environments probably generate a high degree of stress. Charismatic leadership would tend to reduce stress and generate confidence, and perhaps show how uncertainty can be turned into a vision of opportunity and success (Bass, 1985). While charismatic leadership may be more relevant to situations where organization innovation is of major importance, both transactional and transformational (charismatic) leadership are potentially important at the strategic level. Further, Bass (1985) viewed transactional and charismatic leadership as being somewhat complementary in that both could be displayed by the same individual leader. The same items proposed by Waldman *et al.* (2001) were used to measure the two types of strategic leadership: It was assessed by asking the respondents to rate the extent to which their top managers in general exhibit the particular behavior when compared to managers of main competing organizations:

(1) *Transactional leadership*:
   - takes actions if mistakes are made;
   - points out what people will receive if they do what needs to be done;

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- reinforces the link between achieving goals and obtaining rewards;
- focuses attention on irregularities, exceptions, or deviations from what is expected; and
- rewards good work.

(2) *Charismatic leadership*:

- shows determination when accomplishing goals;
- I have complete confidence in them;
- makes people feel good to be around them;
- communicates high performance expectations;
- generates respect;
- transmits a sense of mission; and
- provides a vision of what lies ahead.

Characteristics of the innovation process are defined as the degree to which companies promote "desired" innovation process activities. As previously used by Guimaraes and Armstrong (1998b), this was measured by asking the respondents to rate the importance or focus that the company places on ten areas of the innovation process characteristics. These consisted of: all significant innovations must conform to company objectives, all affected departments participate in the innovation process, individual employee input is considered important, customers input is considered important, business partners input is considered important, ability to balance risk taking with cost/benefit, clearly defined measures to monitor progress, innovation objectives and progress are clearly communicated, responding quickly to required change, and responding effectively to required change. The same seven-point Likert-type scale was used, and the overall rating of characteristics of the innovation process for each firm was determined as the average of the ten areas.

MOT effectiveness in supporting business innovation is the extent to which the company's needs for technology while implementing business innovation have been met. As previously used by Guimaraes and Armstrong (1998a) and Guimaraes *et al.* (1999), this was measured by asking the respondents to rate this for the overall company and in four specific areas: technology leadership in the industry, knowledge of how to get the best technology, effectiveness with which technology has been used over the years, and effectiveness in using technology in comparison with main competitors. The respondents were asked to use the same seven-point scale described above. The measure for MOT effectiveness in supporting business activities is the average of the ratings for these five items.

Industry sector clockspeed measures the variation in rate of change within industry environments. Consistent with Fine (1998), our measure for industry clockspeed consists of assessing the rate of change along nine items grouped into three areas:

(1) Product clockspeed (changes in product models, changes in design of dominant product model, and changes in optional product features).

(2) Process clockspeed (change in dominant processes, change in organizational paradigms i.e. from using lean production to using mass production, and purchases of new equipment and/or production plants).

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(3) Organizational clockspeed (frequency of CEO transitions, frequency of ownership changes, and frequency of organizational restructurings).

Respondents were asked to rate each of the nine items to characterize the frequency of change in their firm's industry sector relative to other sectors, using a seven-point scale ranging from "greatly below average frequency" to "greatly above average frequency."

3.4 Construct validity

Several precautions were taken to ensure the validity of the measures used. Many of the recommendations by Carmines and Zeller (1979) were followed. To ensure content validity, a thorough survey of the relevant literature was undertaken to understand the important aspects of each major variable and its components, and not neglect important dimensions of any variable. To further reduce the possibility of any non-random error, the main source of invalidity (Carmines and Zeller, 1979, p. 15), a group of four practitioners from different companies with extensive experience in managing business innovation reviewed the questionnaire for validity (measuring the phenomena intended), completeness (including all relevant items), and readability (making it unlikely that subjects will misinterpret a particular question). Some questions were reworded to improve readability; otherwise, the items composing each major variable remained as derived from the literature.

As proposed by Carmines and Zeller (1979, p. 27), "construct validation focuses on the extent to which a measure performs in accordance with theoretical expectations." To ensure construct validity, the theoretical relationships between the constructs should have been previously established, and these relationships hopefully have been empirically supported by different studies over time. As discussed earlier, the theoretical underpinnings of this study are relatively well established, with most of the items in each construct having been addressed before by several authors. Second order factor analyses on the two types of strategic leadership (transactional and charismatic leadership) indicate that they can be combined into a single factor. Thus, the subsequent multivariate analysis used the combined factors.

3.5 Construct reliability

Since many of the measures used are relatively new, it was deemed important to re-test their reliability. Carmines and Zeller (1979) identified four basic methods to assess a measure's reliability (re-test, alternative-form, split-halves, and the internal consistency methods) and discussed their strengths and limitations. The main advantage of the internal consistency method is that it requires a single test, in lieu of splitting or repeating of items. "By far the most popular of these reliability estimates is given by Cronbach's alpha" (Carmines and Zeller, 1979, p. 44) which "in most situations provides a conservative estimate of a measure's reliability" (Carmines and Zeller, 1979, p. 45). The authors go on to say "that although more complex computationally, alpha has the same logical status as coefficients arising from the other methods of assessing reliability."

Several authors have proposed different acceptable levels of reliability coefficients. For example, Nunnally (1978) suggested a coefficient of 0.50 or higher would suffice. Srinivasan (1985) and Magal *et al.* (1988) contended that when using a not validated data gathering instrument in exploratory research, a reliability coefficient of 0.5 or higher is acceptable. Van de Ven and Ferry (1980) posited that in this type of research

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even a value of 0.4 or higher will be sufficient. In our case, the reliability coefficients of all the factors were higher than 0.70, which was proposed by Peterson (1994) as useful for more rigorous studies. As Table III indicates, the internal consistency reliability coefficients (Cronbach's alpha) for the scales used in this study are all well above the level of 0.50 acceptable for exploratory studies of this type (Nunnally, 1978).

3.6 Data analysis procedures

The average and standard deviation for each item in the questionnaire were computed. Confirmatory factor analyses for the items in each main variable were conducted as the basis for their validation and as a prerequisite for assessing their internal reliability through the Cronbach's alpha coefficients presented within parentheses in Table III. To test the proposed hypotheses, Pearson's correlation coefficients between the major study variables were computed and presented in Table III. To detect any possible difference between the two strategic leadership types as determinants of business innovation success, they were processed separately in this analysis. Because of the possibility of collinearity among the independent variables, a stepwise multivariate regression analysis was conducted to assess the extent to which each independent variable incrementally contributes to explaining the variance in the dependent variable. In this case the two leadership types were combined since they both were found to be significant determinants of business innovation success and such combination was deemed valid by a second order factor analysis. The multivariate regression analysis results are presented in Table IV.

Moderated multiple regression analysis using the hierarchical technique (Cohen and Cohen, 1983; James and Brett, 1984; Peters *et al.*, 1984; Hair *et al.*, 1995) was performed to assess the moderating effect of industry clockspeed on the relationships between the four independent variables and company innovation effectiveness or success. The results are presented in Tables V and VI.

This data analysis technique has been recommended as preferable to subgroup analysis for testing moderator effects because it makes more complete use of the data and its interaction effect (with the independent variables) on the dependent variable (Zadeck, 1971; Peters and Champoux, 1979; Peters *et al.*, 1984). First, innovation success was regressed on each of the four independent variables. The moderating variable (clockspeed) was added to the regression equation, and the increment in R^2 (and the level of significance associated with the change) were computed. Once the significant relations were identified, the beta coefficients were computed to assess the direction of the relationship.

The increment in R^2 rather than the magnitude of the correlation coefficient was used to determine the relative importance of each independent variable in explaining variation in innovation success (Arnold, 1982; Cohen and Cohen, 1983). The interaction of the moderating variable and each of the factors was added, and the increment in R^2 (and associated significance level) were determined. This procedure makes the most conservative possible estimate of moderating effects as it "assigns to the additive effects all variance that cannot be unequivocally attributed to the interaction effects" (LaRocco *et al.*, 1980). The interaction is denoted in Table V by (independent variable × clockspeed).

To avoid the problems associated with subgroup correlational analysis and to complete the moderator model analyses (Peters and Champoux, 1979; Arnold, 1982;

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Table III.
Correlations between major variables

	Mean	Std dev.	1	2	3	4	5	6	7
1. Innovation success	4.17	1.53	(0.71)						
2. Competitive intelligence	3.34	2.11	0.58**	(0.86)					
3. Transactional leadership	4.02	1.10	0.32**	NS	(0.82)				
4. Charismatic leadership	3.15	1.99	0.38**	0.40**	0.33**	(0.85)			
5. Management of technology	4.26	1.16	0.31**	NS	0.26**	0.20**	(0.91)		
6. Innovation process features	3.73	1.46	0.44**	0.33**	0.25**	0.35**	0.19**	(0.93)	
7. Clockspeed	3.49	1.15	0.21**	NS	0.16*	NS	0.11*	NS	(0.88)

Notes: Numbers in parentheses diagonally are Cronbach's alpha reliability coefficients; NS means not significant; *means $p < 0.05$; **means $p < 0.01$

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Peters *et al.*, 1984), slope coefficients (non-standardized beta coefficients) were used to examine the direction of the significant interactions. Furthermore, to determine whether slope coefficients vary as a function of the interaction, the moderator variable was split into low (below the mean values) and high (above the mean values) groups. The statistical significance level of the differences between respective slope coefficients obtained for the two groups (low and high) were tested by applying the formula proposed by Arnold (1982).

The items comprising each major variable were subjected to a principal component analysis followed by a varimax (orthogonal) rotation to identify composite factors. To be included in a given factor the item is expected to load unambiguously (i.e., with one loading of 0.5 and no other loadings greater than 0.4), as suggested by Magal *et al.* (1988). As suggested by several researchers (i.e. Nunnally, 1978), the minimum eigenvalue for which a factor is to be retained was specified as 1.0. This procedure

Independent variables[a]	Incremental R squared	Significance level
1. Competitive intelligence	0.34	0.00
2. Innovation process features	0.16	0.00
3. Strategic leadership	0.09	0.03
4. Management of technology	0.05	0.04
Total variance explained	0.64	

Note: Dependent variable: innovation success; [a]in the sequence in which they entered the regression equation

Table IV. Results of multiple regression using stepwise method

Independent variable and moderator	Incremental R^2
Competitive intelligence	0.34**
+Clockspeed	0.13**
+Clockspeed × competitive intelligence	0.06*
Total R^2	0.53**
Innovation process features	0.19**
+Clockspeed	0.05NS
+Clockspeed × change process features	0.02NS
Total R^2	0.19**
Strategic leadership	0.18**
+Clockspeed	0.09**
+Clockspeed × strategic leadership	0.05*
Total R^2	0.32**
Management of technology	0.09**
+Clockspeed	0.06*
+Clockspeed × management of technology	0.04*
Total R^2	0.19*

Note: Dependent variable: innovation success; $^{*}p \leq 0.05$; $^{**}p \leq 0.01$ NS = not significant

Table V. Moderated multiple regression results

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produced multifactor solutions for the main variables. Industry clockspeed items loaded unambiguously into three factors. Items 1-3 loaded into one dealing with product changes; items 4-6 loaded as a factor named "process changes"; and items 7-9 produced a factor dealing with organizational changes.

As a requirement to compute reliability coefficients for each multi-factor construct measure, second order factor analyses were done on the extracted factors to ensure that they could be treated as one construct. In all cases, the analyses showed that the extracted factors can be combined (loaded unambiguously) into main single factors corresponding to the main variables in the model tested in this study. Based on the stated objectives of this study, further analyses used the combined factors.

4. Results

Table III lists the means and standard deviations for the main research variables. As a group, in comparison with their main competitors, the companies in the sample are thought to be performing above average in the areas of implementing business innovation, and management of technology. On the other hand, on the average the companies in the sample are thought to be performing below average in the areas of charismatic leadership, competitive intelligence, and having the specific characteristics of change process needed for success in business innovation. The relatively large standard deviations indicate significant differences along all the major variables from company to company.

To test *H1-H4*, Pearson's correlation coefficients were computed and presented in Table III. All four independent variables show a direct relationship to success in business innovation, as defined in this study. Thus, based on these correlation coefficients, all four hypotheses are found significant at the 0.01 level or better. Because of the possibility of collinearity among the independent variables, a stepwise multivariate regression analysis was conducted to assess the extent to which each independent variable incrementally contributes to explaining the variance in the dependent variable. Table IV shows that, dependent on the sequence in which the independent variable entered the regression equation, competitive intelligence explains 34 percent of the variance in innovation success, followed by the features of the innovation process, strategic leadership, and management of technology. Each independent variable makes a contribution to that effect at a significance level below 0.05.

Table VI.
Moderated model slope coefficients for independent variables on innovation success

Independent variable	Moderator Variable	Slope[a] Low	Slope[a] High	Adjusted R^2 Low	Adjusted R^2 High
Competitive intelligence	Clockspeed	0.26*	0.48*	0.33*	0.31*
Innovation process features	Clockspeed	0.35*	0.39*	0.24*	0.27*
Strategic leadership	Clockspeed	0.30*	0.46*	0.28*	0.35*
Management of technology	Clockspeed	0.21*	0.36*	0.19*	0.23*

Notes: [a]Two separate equations were obtained, one for the low (below the median) moderator group, the other for the high (above the median) moderator group. Slope coefficients (non-standardized beta weights) for low and high moderator groups are significantly (0.01 or lower) different for competitive intelligence, strategic leadership and management of technology; $^{*}p \leq 0.01$

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4.1 Results regarding clockspeed as moderating variable

The moderated regression results are presented in Table V. As explained earlier, the increment in R^2, rather than the magnitude of the beta coefficients, is used to determine the relative contribution of the correlated independent variables in explaining variation in the dependent variable. Results in Table V also show that clockspeed showed significant interaction effects on the relationships between competitive intelligence, strategic leadership, and management of technology with the dependent variable innovation success.

Using a procedure described by Hunt *et al.* (1975), the interaction effects noted in Table V were analyzed further to determine the direction of the moderating effects on the relationships between the independent variables and innovation success. As noted by several researchers (Hunt *et al.*, 1975; Peters and Champoux, 1979; Arnold, 1982; Peters *et al.*, 1984), an infinite number of slope coefficients (nonstandardized coefficients) can be computed within a moderated multiple regression model. Peters and Champoux (1979, p. 91) recommended that the slope coefficients be used for analysis because they "suggest the differential impacts which are likely to occur from interventions targeted at alternative groups and alternative variables." Following the procedure used by Hunt *et al.* (1975), values for the moderating variable falling above or below the median value were used to obtain two equations. The equations, one for the low (below the median) values and the other for the high (above the median) values of the moderating variable, were used to regress the independent variables on innovation success. Table VI presents the results of these analyses. It shows that the low and high groups for clockspeed differed significantly with respect to the relationship between competitive intelligence, strategic leadership, and management of technology with the dependent variable innovation success. The slope coefficients and R^2 for these three independent variables are statistically significant at the 0.05 or lower significance level. These results confirm the strength of the interaction effects found in the moderated regression analysis. Based on the results in Tables V and VI, *H1b*, *H2b*, and *H3b* are accepted at the 0.05 significance level or better.

5. Conclusions

The results provide strong evidence regarding the importance of strategic leadership, competitive intelligence, management of technology, and specific characteristics of the company's innovation process to the success of business innovation regarding products, business processes, organization structure, and organization culture. Given the importance of effectively implementing business innovation in these days of hyper competitiveness, it behooves top managers to do whatever they can to improve their company's performance in the areas of competitive intelligence, strategic leadership, management of technology, and characteristics of the process used to implement the necessary innovations.

Regarding CI, there are some major implications from this study results. To improve their CI programs, managers need to consider the collection of market intelligence based on the six areas addressed in this study: the traditional industry competitors, emerging competitors, traditional customer needs and wants, non-traditional customer needs and wants, relationships with business partners, and new product or service development. The importance of any one of these areas may be relatively higher or lower, and in some cases some of these sources may be irrelevant,

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depending on the company's specific industry sector, line of business, products, and processes being considered. Good performance in these areas, whenever applicable to the company's industry sector and lines of business, are likely to lead to more effective implementation of business innovations. Also, before embarking in major programs for business innovation such as TQM and/or BPR, which are supposedly market driven, the implications for company strategic competitiveness from these changes should be validated with CI information, rather than superficial guesswork by top managers or BPR consultants more focused on the innovation process instead of the strategic reasons for change. At the very least, the market reaction must be carefully considered by any team charged with projects involving significant innovations to business processes, products, and/or the organization itself. As our sample indicates, on average companies are performing below average in this area most important to successful business innovation.

In the area of strategic leadership there are also several implications that can be derived from this study. Charismatic leadership (showing determination while accomplishing goals, inspiring confidence, making people feel good around you, communicating expectations for high performance, generating respect, transmitting a sense of mission, and providing a vision of what lies ahead) is on average and as a whole relatively scarce in industry today, and judging by its nature it should be difficult to develop. Nevertheless, managers must try, particularly in high clockspeed industry sectors (Guimaraes *et al.*, 2002) requiring continuous innovation. Also apparently important for successful business innovation but less scarce than charismatic leadership, transactional leadership (taking action if mistakes are made, pointing out what people will receive if they do what needs to be done, reinforcing the link between achieving goals and obtaining rewards, focusing attention on deviations from what is expected, and rewarding good work) by its nature should be easier to develop. Pawar and Eastman (1997) proposed that transactional leadership is more relevant within an existing organization environment instead of one attempting to implement changes. Katz and Kahn (1978) argued that charismatic leadership may be more relevant where organization change is important, but that both types of strategic leadership are potentially important. Our results indicate that for successful business innovation both types of leadership are important.

To improve technology management while implementing business innovation, managers must look at company performance in terms of its technology leadership position in its main industry sectors, knowledge of how to get the best technology available, effective use of specific technologies, and benchmarking the use of specific technologies against the company's main competitors or best-in-class target organizations. An important requirement to accomplish these objectives is the clear definition of the more important technologies necessary to support the company's main products and business processes, and technologies which will enable the structural and cultural changes considered important to improve company competitiveness. Another important requirement is management recognition that the implementation of each of the various technologies deemed important to the organization is dependent on specific success factors. The success factors for the various technologies have been identified and discussed elsewhere (Guimaraes *et al.*, 1992; Udo and Guimaraes, 1994; Yoon, Guimaraes and Clevenson, 1995; Yoon, Guimaraes and O'Neal, 1995; Guimaraes and Igbaria, 1997; Yoon *et al.*, 1998) and are considered beyond the scope of this paper.

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Further, to improve the likelihood for innovation success, top managers must ensure that their company's change process bear the desirable characteristics studied here: all significant changes must conform to company objectives, all affected departments participate in the change process, individual employee input is considered important, customers input is considered important, business partners input is considered important, managers ability to balance risk taking with cost/benefit, ensuring that clearly defined measures to monitor progress exist, that innovation objectives and progress are clearly communicated, and that the innovation management teams respond quickly and effectively to required change. These guidelines must be widely disseminated and enforced by project managers responsible for significant business innovations.

The effect of industry clockspeed on innovation success is significant. Thus, the above recommendations regarding strategic leadership, competitive intelligence, and management of technology are particularly important for companies operating in high clockspeed industry sectors. The only independent variable which is equally important to low and high clockspeed industries are the prescribed characteristics for the projects implementing the business innovations. This could be related to the finding by Perrons and Platts (2005) that industrial clockspeed did not play a significant role in the success or failure of a particular outsourcing strategy for radical innovation.

5.1 Study limitations and research opportunities

Based on an extensive survey of the relevant literature, this study is a first attempt at empirically testing the importance of industry clockspeed as an influence in the connections between strategic leadership, competitive intelligence, management of technology, and specific characteristics of the company's innovation process for the success of business innovation projects. While the tested model represents a major contribution as an integration of several constructs which in the past have been studied in isolation, this model may need to be expanded further to include other factors potentially important to effective implementation of strategic business innovation. Another important contribution from further research could be the identification and empirical testing of other variables besides clockspeed which might moderate the relationships between the independent variables and success in business innovation. Perhaps the use of path analytic modeling techniques would be applicable for these studies involving more extensive models. The results should provide valuable information on other possible determinants of innovation success, as well as on the extent to which strategic leadership can positively influence the effective use of technology, and CI programs, for companies to improve their business competitiveness, while ensuring that their innovation processes follow the prescribed guidelines suggested in this study.

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