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Organizational learning culture, innovative culture and innovations in South Korean firms

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ABSTRACT

The aim of this paper is to present and test a model of innovativeness improvement based on the impact of organizational learning culture. The concept of organizational learning culture (OLC) is presented and defined as a set of norms and values about the functioning of an organization. They should support systematic, in-depth approaches aimed at achieving higher-level organizational learning. The elements of an organizational learning process that we use are information acquisition, information interpretation, and behavioral and cognitive changes. Within the competing values framework OLC covers some aspects of all four different types of cultures: group, developmental, hierarchical, and rational. Constructs comprising innovativeness are innovative culture and innovations, which are made of technical (product and service) and administrative (process) innovations. We use data from 201 Korean companies employing more than 50 people. The impact of OLC on innovations empirically tested via structural equation modeling (SEM). The results show that OLC has a very strong positive direct effect on innovations as well as moderate positive indirect impact via innovative culture.

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1. Introduction

Business and technological changes are threatening organizational sustainability and modern management faces many challenges (Drucker, 1999). Organizations are continually under competitive pressures and forced to re-evaluate come up with new innovations. An innovation can be a new product or service, a new production technology, a new operation procedure or a new management strategy to an enterprise (Damanpour, 1991; Liao, Fei, & Liu, 2008; Nonaka & Yamanouchi, 1989; Tushman & Nadler, 1986; Zaltman, Duncan, & Holbeck, 1973). Innovations have always been essential for the organizations' long-term survival and growth and currently play even more crucial role in the company's future to follow the rapid pace of markets' evolution (Santos-Vijande & Álvarez-González, 2007).

In the literature innovations are differentiated as product vs. process (Abernathy & Utterback, 1978; Davenport, 1993; Han, Kim, & Srivastava, 1998), radical vs. incremental (Atuahene Gima, 1996; March, 1991), and technical vs. administrative (Daft, 1978;

Damanpour, Szabat, & Evan, 1989; Han et al., 1998; Weerawardena, 2003). Moreover, a true innovative firm must be embedded of a strong culture that stimulates the engagement in innovative behavior. Innovativeness is hence comprised of two constructs – innovations and innovative culture.

The body of literature that has studied the relation between organizational learning and innovation is growing and suggests that organizational learning would enhance the innovative capacity of an organization and that firms can only innovate if they develop an efficient learning of their resources, competencies and capabilities (Akgün, Keskin, Byrne, & Aren, 2007; Alegre & Chiva, 2008; Argyris & Schön, 1978; Calantone, Cavusgil, & Zhao, 2002; Chipika & Willson, 2006; Helfat & Raubitscheck, 2000; Sinkula, Baker, & Noordewieer, 1997; Stata, 1989). Similarly, studies increasingly stress organizational culture as a key to managing innovation (e.g. Jassawalla & Sashittal, 2002; Khazanchi, Lewis, & Boyer, 2007). Yet, there is a lack of investigation of the relation of organizational learning culture and innovativeness. What is too often neglected is not just knowledge needed, acquired and processed, but rather a right set of attitudes and values needed for innovations to occur (see e.g. Terziovski, 2008).

The basic idea behind this paper is that organizational learning culture is very important when trying to improve innovativeness. The paper addresses organizational learning culture, which is proposed and defined as a set of norms and values about the functioning of an organization. It is a combination of different culture types

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within the competing values framework (Denison & Spreitzer, 1991; McDermott & Stock, 1999). The purpose of the paper is to present and test a model of innovativeness improvement. Hence, the focus of this study is on the impact organizational learning culture has on innovativeness (innovative culture and innovations).

The outline of the paper is as follows: Section 2 reviews the relevant literature in order to demonstrate our specific contributions. Section 3 conceptualizes the research model leading to the development of suitable hypotheses. Section 4 aims to present a methodological framework for the study, while Section 5 provides results of data analysis. Section 6 concludes with a summary of the main findings, discusses them from theoretical and practical standpoints, and outlines directions for future research together with the limitations of the study.

2. Literature review

2.1. Organizational culture and innovations

Many different people have used the word ‘culture’ to explain a variety of phenomena. As each one tends to adopt a slightly different perspective, there is no universally accepted definition (Rollinson & Broadfield, 2002). Ott (1989) identified over 70 different words or phrases used to define organizational culture. One of the first attempts was by Jacques (1952) who claimed that organizational culture is the customary and traditional way of doing things, which is shared to a greater or lesser degree by all members, and which the new members must learn and at least partially accept in order to be accepted for the firm’s services. Harrison (1972) focused more on culture itself rather than on its effects and defined it as ideologies, beliefs, and deep-set values that occur in all firms and are prescriptions for the ways in which people should work in these organizations. Peters and Waterman (1982) saw culture as a dominant and coherent set of shared values conveyed by symbolic means such as stories, myths, legends, slogans, anecdotes and fairy tales. Deal and Kennedy defined organizational culture as “the way things get done around here” (1982, p. 90).

Schein (1992) perceived organizational culture as a pattern of basic assumptions – invented, discovered or developed by a given group as it learns to cope with its problems of external adaptation and internal integration. Such a pattern has worked well enough to be considered valuable and, therefore, to be taught to new mem-

bers as the correct way to perceive, think and feel in relation to those problems. Wiener claimed that “most researchers of organizational culture agree that shared values are a key element in the definition of culture” (1988, p. 534).

Organizational culture has many dimensions and variations. The competing values framework (CVF) categorizes them in a two-dimensional space (Denison & Spreitzer, 1991); see Fig. 1. Each axis represents contrast orientations. The first dimension stands for flexibility vs. control orientation. The second dimension describes the focus on activities occurring within or outside the organization. The combination of both dimensions defines four types of organizational culture: group, developmental, hierarchical, and rational. Group culture emphasizes flexibility and change and a focus on the internal organization. Developmental culture also emphasizes flexibility, but is externally focused. Rational culture is externally oriented, but focused on control. Hierarchical culture emphasizes stability; however, the focus is on the internal organization. Characteristics of all four types of cultures are represented in Fig. 1 and are further described in Denison and Spreitzer (1991), McDermott and Stock (1999) and Prajogo and McDermott (2005).

An important assumption of CVF is that each type of culture is an ideal type. The culture in an organization is a combination of different culture orientations, although usually one type is more dominant than the others. “A high rating on one dimension, e.g. internal orientation, does not exclude high rating at the other end, e.g. external orientation” (McDermott & Stock, 1999, p. 525). Further, Denison and Spreitzer (1991) argued that overemphasizing any culture type may become dysfunctional and the strength of the quadrant may even become a weakness.

While there is a consensus that organizational culture is critical in any change initiative, no such consensus exists as to what type of organizational culture best supports business transformation and innovativeness. A lack of empirical investigations into organizational culture on various aspects of innovativeness is still noted. Only a few studies have tackled some aspects of this issue in recent years (e.g. Kandemir & Hult, 2005; Kusunoki, Nonaka, & Nagata, 1998; Martins & Terblanche, 2003; Merx-Chermin & Nijhof, 2005; Sarros, Cooper, & Santora, 2008). Findings of Prajogo and McDermott (2005) indicate that an organization can implement different, even opposite culture types, in harmony. This opened up the question of which combination of culture types is most appropriate for innovations. Škerlavaj, Indihar Štemberger,

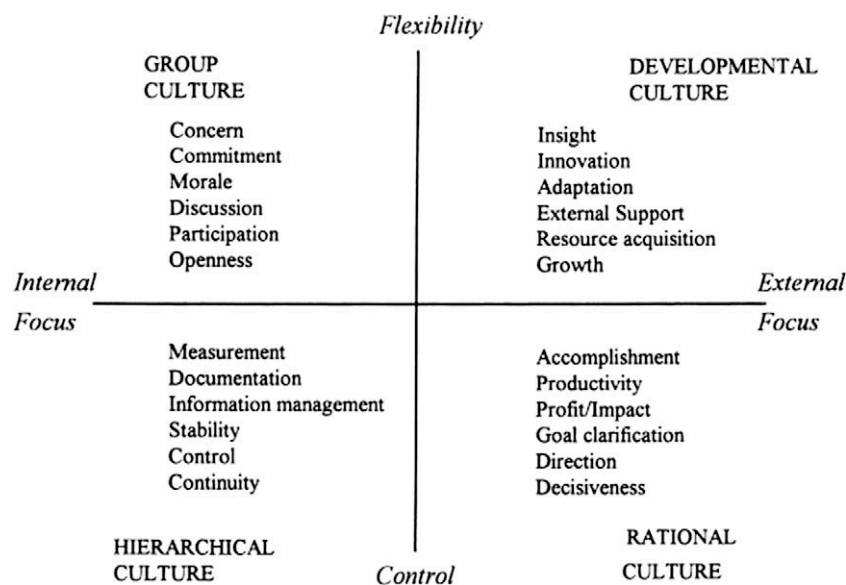


Fig. 1. The competing values framework (Denison & Spreitzer, 1991; McDermott & Stock, 1999).

Škrinjar, and Dimovski (2007) suggest the organizational learning culture as a combination of all four cultural types as shown in Section 3. The purpose of this paper is to show that organizational learning culture leads to superior innovativeness.

2.2. Organizational learning culture

Organizational learning is a complex process that refers to the development of new knowledge and has the potential to change behavior (Huber, 1991; Slater & Narver, 1995). It is a time-honored process that involves changing individual and organizational behavior (Murray & Donegan, 2003). Firms that have developed a strong learning culture are good at creating, acquiring and transferring knowledge, as well as at modifying behavior to reflect new knowledge and insight (Garvin, 1993; Huber, 1991). Hence, organizations stressing organizational learning culture (OLC) must first acquire information, interpret it to fully understand its meaning and transform it into knowledge. At the same time, they must not forget the most important part – to implement behavioral and cognitive changes – in order to convert words into action.

Like organizational culture, organizational learning is also a very elusive concept due to the variety of perspectives that come under scrutiny in the academic literature. There have been numerous attempts to define organizational learning and its various aspects. Senge (1990) defined organizational learning as “a continuous testing of experience and its transformation into knowledge available to whole organization and relevant to their mission” (p. 6), while Huber (1991) saw it as a combination of four processes: information acquisition, information distribution, information interpretation and organizational memory. Argyris and Schön (1996) were even less restrictive in their definition by declaring that organizational learning emerges when organizations acquire information (knowledge, understandings, know-how, techniques and procedures) of any kind by any means.

Jones (2000) emphasizes the importance of organizational learning for organizational performance. He defines it as “a process through which managers try to increase organizational members’ capabilities in order to better understand and manage the organization and its environment” (Jones, 2000, p. 472). Dimovski (1994) provided an overview of previous research and identified four varying perspectives on organizational learning. His model managed to merge informational, interpretational, strategic and behavioral approaches to organizational learning and defined it as a process of information acquisition, information interpretation and resulting behavioral and cognitive changes which should, in turn, have an impact on innovativeness.

2.3. Innovativeness

The current situation of the environment (e.g. uncertainty, high risk and volatility) involves that firms need develop innovations in order to maintain or increase their competitiveness. The capacity to innovate is among the most important factors that impact business performance (Hurley & Hult, 1998). Innovativeness provides flexibility for firms to choose different options to satisfy their customers on a sustainable basis so that this will provide a basis for the survival (Banbury & Mitchell, 1995).

Innovativeness is a process of turning opportunities into practical use (Tidd, Bessant, & Pavitt, 1997) and is such only when it is really adopted in practice (Schumpeter, 1934). It is an interactive process in which firms interact both with customers and suppliers and with knowledge institutions (Freeman, 1987; Kline & Rosenberg, 1986). Innovation has been recognized as a key element of dynamic efficiency and competition of markets since the work of Schumpeter (1934). Innovators should share the market with non-innovators and grow at their expense. In general, innovator

will grow faster, be more efficient and more profitable than non-innovators (Mansury & Love, 2008). For this reason, innovativeness is a competitive instrument essential for firms’ long-term success and survival (Deshpande, Farley, & Webster, 1993).

The degree of innovation reflects the extent of new knowledge embedded in an innovation (Dewar & Dutton, 1986; Ettlie, 1983). Firms with greater innovation capability will achieve a better response from the environment, obtaining more easily the capabilities needed to increase organizational performance and consolidate a sustainable competitive advantage (Calantone et al., 2002; Zaltman et al., 1973). For this reason is necessary to improve the innovative culture of the enterprise so that all its members search new product, services or processes (innovations involve a change, something new – e.g. novel ideas or behaviors).

If an enterprise wants to increase its innovations capacity is necessary high level of creativity (Cohen & Levinthal, 1990). They consider that creativity is necessary so that firms resolve problems related with knowledge generation and absorptive capacity. Creativity is the generation of novel and appropriate ideas, products, processes, or solutions (Amabile, 1983; Shalley, 1995). The management of the flow of technological information is an important part of an organization’s innovative capacity (Cohen & Levinthal, 1990) and leads to effective generation of ideas. Moreover, Koc and Ceylan (2007) consider that if companies wish to become and remain innovative, they should pay special attention to variables as technology strategy, quality of ideas, as well as technology acquisition and exploitation. The conversion of technical ideas into new business, products or services can be based on the understanding of the synergies and interactions between the different knowledge possessed by the firm, their technologies, their organizational learning process, and their internal organization (Guadamillas, Donate, & Sánchez de Pablo, 2008).

Using the model developed in the paper we seek to show that an organizational learning culture can contribute to innovativeness and upgrade prior knowledge from several perspectives. First, we believe we use an approach (Škerlavaj’s et al., 2007) that has expanded the concept of organizational learning culture from the competency perspective alone to a notion that covers the process component while not disregarding the importance of linking learning opportunities with organizational activities. Second contribution of our study is linked to the investigation of a very important research question how to augment innovativeness within organizations. By doing so, we learn from experiences of companies from fast-growing context of the Republic of Korea, a context much less studied than traditional Western countries.

3. Conceptualization of the research model

3.1. Operationalization of the organizational learning culture construct

There have not been too many attempts to define and operationalize organizational learning culture (OLC) in the past. For instance, Watkins and Marsick (1993, 2003) developed an analytical framework of the learning organization, which was used in the study by Egan, Yang, and Bartlett (2004) as a substitute for learning culture. Having done that, they seemed to neglect the fact that the organizational learning culture and learning process are implicitly intertwined. According to Song and Chermack (2008), organizational learning needs to be integrated with individual learning process under the supportive organizational learning culture to improve innovative knowledge creation practice in the organization, which increases the chances of organizational innovativeness. They also appeared to neglect that the integration of a four-stage process that includes information acquisition, information dissemination, information interpretation and organizational memory can

provide a better understanding of the learning culture's role in achieving superior organizational performance as shown by [Kandemir and Hult \(2005\)](#).

We use a [Škerlavaj et al. \(2007\)](#) definition that understands OLC as a set of norms and values about the functioning of an organization ([Schein, 1992](#)) that support systematic, in-depth approaches aimed at achieving higher-level, i.e. double-loop ([Argyris & Schön, 1996](#)), deuterio ([Schön, 1975](#)), strategic ([Bhattacharya, 1985](#)) or generative ([Wittrock, 1974, 1990, 1992](#)) organizational learning through phases of information acquisition, information interpretation and accompanying behavioral and cognitive changes ([Dimovski, 1994; Garvin, 1993; Huber, 1991](#)).

In order to explain the concept of OLC further [Škerlavaj et al. \(2007\)](#) use the competing values framework developed by [Denison and Spreitzer \(1991\)](#) and describe the main characteristics of OLC by placing them in the two-dimensional space of CVF. Items used are presented in Appendix A. The main characteristics of OLC are predominantly located within the flexibility orientation, even though some scales emerge also at control orientation. Internal and external focus is equally represented in various traits of OLC. Hence, OLC predominantly covers developmental and group culture, while it also has aspects of hierarchical and rational organizational culture. [Fig. 1](#) shows the placement of OLC in CVF adapted according to the results of exploratory factor analysis ([Appendix B](#)).

Organizational learning culture thus contains elements of all four ideal types of cultures defined in CVF (as evident from [Fig. 2](#)). In its essence, OLC is a flexible culture that acknowledges both internal and external environments. The flexibility is complemented with some elements of the control dimension that provide the clarity, structure and formal reference framework needed for the firm's successful functioning ([Škerlavaj et al., 2007](#)).

3.2. Operationalization of organizational innovativeness

There are several typologies of innovations and innovativeness in the literature. The traditional classification distinguishes between (1) product and (2) process innovation (e.g. [Abernathy & Utterback, 1978](#)). Innovation does not only refer to a new product or service. Moreover it is possible to modify the way how the enterprise obtains the final product (a process innovation). For instance, a new machine disposition, new channels for product and

services, new markets, pricing methods or distribution methods, new employee reward schemes or new computer based administration. The distribution of firms' resources between product and process innovation depends on the market phase of the relevant technology ([Abernathy & Utterback, 1978](#)). Similarly, there is a distinction between administrative or technical innovations. [Daft \(1978\)](#) develops a "dual core" model: (1) administrative innovations occur in the administrative process and affect the social system of an organization, that is, its rules, roles, procedures and structures that are related to the communication and exchange between organizational members and (2) technical innovations, which pertain to products, services and the organization's production process or service operations ([Damanpour, 1991](#)).

Another typology defines incremental vs. radical innovation and shows the strength of innovation. Incremental innovation is related with exploitative learning ([March, 1991](#)) which is the acquisition of new behavioral capacities framed within existing insights. On the other hand, radical innovation is related with explorative learning ([March, 1991](#)) which occurs when organizations acquire behavioral capacities that differ fundamentally from existing insights. [Schumpeter \(1934\)](#) points out that radical innovation can cause a period of creative destruction in a sector. Then it is possible that start to reduce the profit of the firms which are established in this sector because of their disadvantage of their technologies in comparison with new innovations. For this reason, it is very important that enterprises improve their innovation capacity in order to adapt to the new situation and maintain their competitiveness.

Normally, innovations involve changes in working practices and social organization that threaten established hierarchies. For this reason, there are occasions that innovations bring about resistance that may threaten the project and even lead to it being abandoned ([Smith, 2007](#)). Moreover, [Maidique \(1980\)](#) shows that the reluctance of middle managers to take risks, leads them to favor incremental innovations rather than radical ones. On this way, [Christensen \(1997\)](#) points out that manager in established firms tend to favor incremental innovations when faced with disruptive technologies. Either way, this research implicitly points out to the importance of attitudes and values (hence, organizational culture) for the innovativeness of an organization.

Should firms want to develop an effective innovation is necessary to improve the innovative culture so that all enterprise

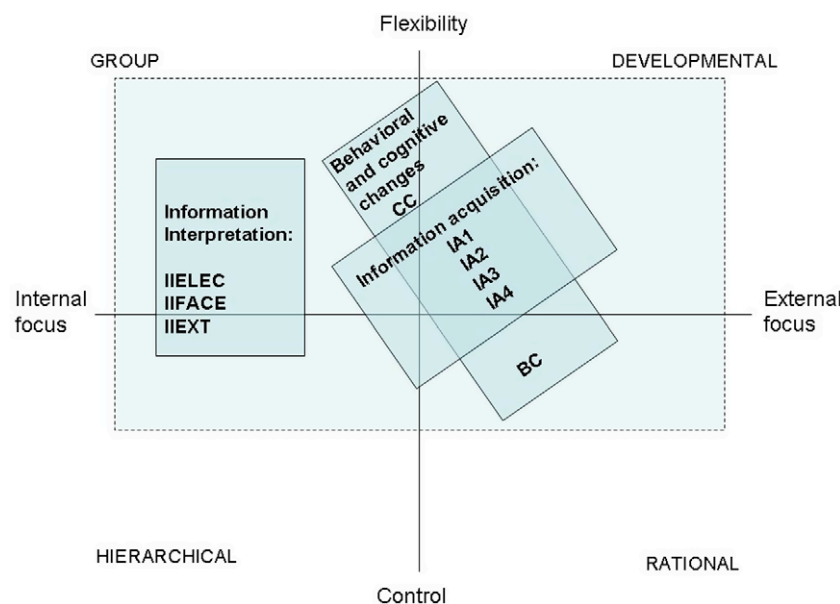


Fig. 2. Organizational learning culture in the competing values framework (adopted from [Škerlavaj et al. \(2007\)](#)).

employees analyze continuously the customer needs and the market evolution in order to introduce novelties and become a cutting-edge enterprise. Moreover, it is important that employees directly check the viability of their ideas in the marketplace (Dombrowski et al., 2007). Innovativeness implies a firm being proactive by exploring new opportunities rather than merely exploiting current strengths (Menguc & Auh, 2006).

Simpson, Siguaw, and Enz (2006) point out that firms need an ability to innovate continuously, for this they must have a set of organization-wide shared beliefs and understanding. Then, firms must modify their cultures in order to develop the innovative culture. Subramanian (1996) consider that organizational characteristic of innovative organizations are different from those of non-innovative companies. Dombrowski et al. (2007) identify eight elements of organizational innovative culture: (1) innovative mission and vision statements; (2) a culture of democratic, lateral communication without the chains of hierarchy in order to attract and retain talented individuals who are so necessary for pursuing experimentation and innovation (Hamel, 1999); (3) forms of safe innovative environments that allows for the mysterious innovation process; (4) flexibility; (5) collaboration across various organizational boundaries; (6) sharing and teaching among and across business units and alliances can be an effective way of promoting collaborative innovation (De Long & Fahey, 2000); (7) incentive schemes based in work teams can foster innovative culture; and (8) leadership is necessary to encourage innovation, for which is necessary big aspirations, a flexible definition of their businesses, and a habit of experimentation.

Innovation is closely linked to the development of technology, but when an innovation fails it is more often fault related to managerial and organizational (people) aspects than to technology itself. So, we can observe the relation between the previous typologies. There are a lot of researches which has focused on technical innovation (Freeman & Soete, 2000). These researches have been criticized in studies of organizational innovation (Avlonitis, Pappastathopoulou, & Gounaris, 2001; Easingwood, 1986). In line with several authors (e.g. Atuahene Gima, 1996; Damanpour et al., 1989; Han et al., 1998) we consider that a technical (product and service) innovations need to be combined with administrative (process) in order to get full picture of organizational innovations. For this reasons, we understand organizational innovativeness as a combination of two constructs: (1) innovative culture and (2) innovations in products and services (technical innovations) and in processes (administrative innovations).

3.3. Research hypotheses and model

Several authors have studied the impact of different types of organizational cultures on various aspects of innovativeness (e.g. Claver, Llopis, Garcia, & Molina, 1998; Deshpande & Farley, 2004; Feldman, 1988; Jassawalla & Sashittal, 2002; Khazanchi et al., 2007; Lau & Ngo, 2004; Lemon & Sahota, 2004; Santos-Vijande & Álvarez-González, 2007).

However, not many studies have evaluated the impact of organizational learning culture on innovativeness. In one of those rare studies, Kandemir and Hult (2005) explore organizational learning culture in international joint ventures and link it innovations. They propose that organizational learning culture has a positive direct effect on its cultural innovativeness and both direct as well as indirect positive impact on innovation capacity. However, they remain at conceptual level and do not test their model empirically. They also limit their understanding of innovations to innovation capacity rather than employing dual core model of innovations. In their seminal work, Nonaka and Takeuchi (1995) propose that supportive organizational learning culture would be the critical factor to link several innovative components inside organization as well as internationally. In addition, Khazanchi et al. (2007) explored how

organizational values, which is a main part of organizational culture impact a process innovation via the implementation of advanced manufacturing technology.

In their work on organizational culture(s) and TQM practices Prajogo and McDermott (2005) find support for the pluralist view, which “suggests the existence of multidimensional cultures” (p. 1107). It is in this way that we understand organizational learning culture as a combination of values and norms that support group, developmental, and to some extent also hierarchical and rational culture (according to CVF). We start from the basic research question which deals with the question of the impact of organizational learning culture on organizational innovativeness, and develop hypotheses accordingly.

Organizational learning process is a sequence of three phases: information acquisition, information interpretation, and behavioral and cognitive changes. Organizations with a strong organizational learning culture place high importance on the acquisition of operational, tactical and strategic information from internal as well as external sources. Information can be regarded as a raw material for learning. In the next phase, this information needs to be transformed into meaning through the information interpretation phase. Firms that value the interpretation of information use face-to-face and electronic channels both internally as well as externally. For learning to happen, information needs to be acquired, understood, and above all transformed into action (Garvin, 1993; Huber, 1991). Both behavioral and cognitive changes in the functioning of organizations are needed for learning to be effective (Garvin, 1993; Murray & Donegan, 2003). All three phases of the organizational learning process need to be assigned with a high level of importance in order to claim that an organization has a strong learning culture. On this basis we pose the first two hypotheses:

H₁. Ascribing greater importance to the acquisition of information (In foacq) leads to the better interpretation of information (Infoint).

H₂. Assigning greater importance to interpreting information (Infoint) leads to more action in terms of behavioral and cognitive changes (Bcc).

Another set of hypotheses should relate organizational learning culture to innovativeness. Positive changes in the way people act (behavioral changes) and perceive their internal and external environments (cognitive changes) are expected to have a positive impact on both innovative culture (Kandemir & Hult, 2005) as well as technical and administrative innovations. Specifically, changing actions and cognitive maps of members of an organization should lead to the understanding that innovation proposals are welcome in organizations, that people are encouraged to experiment in order to be creative, and in higher-level of managerial support and seeking for innovative ideas and creative processes. Strong organizational learning culture hence supports values and beliefs related to innovative culture. In turn, culture that values creativity, experimentation and innovation should results in more technical as well as administrative innovations.

H₃. Improved behavioral and cognitive changes (Bcc) will have a positive impact on innovative culture (Iculture).

H₄. Improved innovative culture (Iculture) will have a positive impact on technical and administrative innovations (Innov).

At the same time, a strong organizational learning culture should mean that an organization learns and acts faster and is therefore better in dealing with its innovation processes. Organizational learning culture should therefore also have a direct link to augmented technical and administrative innovations. If members of an organization have the necessary information, fully understand its meaning and opportunities and are able to convert it into

action, this should mean that can be more innovative. In this context, Hypotheses 3–5 are put forward:

H₅. Improved behavioral and cognitive changes (Bcc) will have a positive impact on technical and administrative innovations (Innov).

In Fig. 3, we illustrate the conceptualized research model in which all the main constructs are shown together with the hypothesized relationships among them.

4. Research framework and methodology

4.1. Research instrument

In order to test our hypotheses, we used previously tested valid and reliable structured questionnaires (see Appendix A). To measure organizational learning culture we used Škerlavaj et al. (2007) instrument with three constructs and 42 items on five-point Likert scales. In order to measure innovativeness we used items from Daft (1982), Tsai (1997) from Liao et al. (2008), Wang and Ahmed (2004) for innovations and from Hurley and Hult (1998) for innovative culture.

4.1.1. The organizational learning culture measures

As discussed in the literature review, we used Škerlavaj et al. (2007) understanding of organizational learning culture that relates the process of organizational learning (Huber, 1991) to the competing values framework of organizational culture (Denison & Spreitzer, 1991; McDermott & Stock, 1999; Prajogo & McDermott, 2005). Hence, we understand the concept of organizational learning culture to be composed of three constructs: information acquisition (Infoacq), information interpretation (Infoint), and behavioral and cognitive changes (Bcc). Nine composite scores of items are used for their formation.

4.1.2. The organizational innovativeness measures

We understand organizational innovativeness as a set of two constructs: innovative culture (Iculture) and technical and administrative innovations (Innov). Innovative culture (Iculture) is a first-order construct with five items, while innovations (Innov) are second-order construct composed of constructs product and service (technical) innovations (Ti) and process (administrative) inno-

vations (Ai). Ti is measured using nine items, while Ai is measured with four perceptual items.

4.2. Data collection and sample characteristics

In winter 2008, empirical data were collected through a survey of 243 Korean companies that had more than 30 employees. Questionnaires were addressed to senior and middle managers estimated as having adequate knowledge of the organizational culture and performance within their companies. Two-hundred and seven managers responded this accounts for response rate 85.2%.

We originally aimed at an audience of top managers to ensure a strategic and to some degree even an interdisciplinary perspective on the company in question. However, there was some discrepancy between the desired and actual structures of respondents as shown in Table 1.

Based on the criterion of the average number of employees in 2008, 44.9% of the companies had between 50 and 249 employees, followed by 16.9% with 250–499 employees, while 8.6% had 500–999 and 27.1% of the companies had 1000 and more employees (data not available: 2.5%). Table 2 demonstrates the industry structure of the companies under investigation. Given that non-profit organizations were excluded from the study, the sample is an adequate representation of the population of Korean companies that have more than 30 employees.

4.3. Research methods

For the purpose of validating the measurement instrument and modeling the structural relationships among the various

Table 1
Structure of respondents by their function within the company.

Respondent's function	Share (in %)
Senior director of HRM	42.6
Middle manager of production	21.3
Senior director of HRD	15.9
CEO or managing director	4.8
Data not available	2.4
Other	13.0
Total	100.0

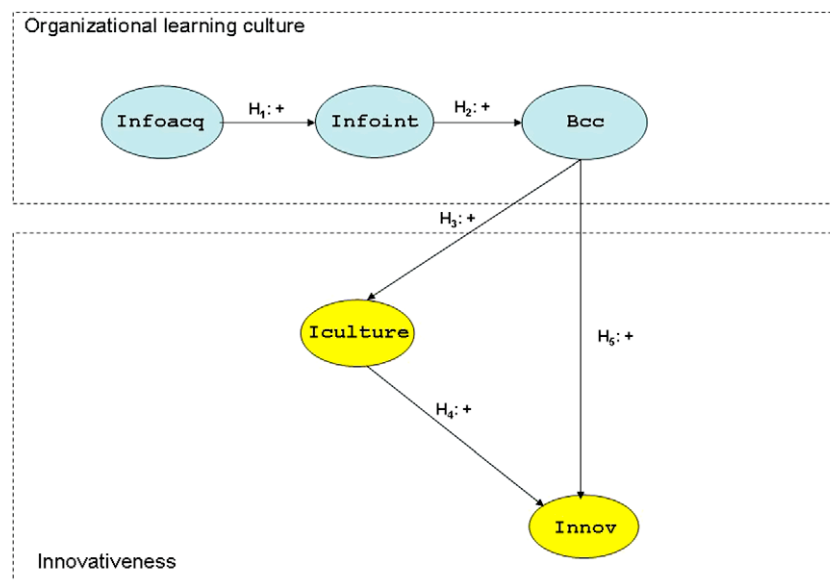


Fig. 3. The conceptualized research model.

Table 2
Structure of respondents by industry type.

Industry (SIC)	Share (in %)
A: Agriculture, hunting and forestry	0.1
B: Fishing	0.0
C: Mining and quarrying	0.0
D: Manufacturing	36.7
E: Electricity, gas, and water supply	0.0
F: Construction	5.3
G: Wholesale and retail trade	12.6
H: Hotels and restaurants	0.1
I: Transport, storage and communication	7.2
J: Financial intermediation	17.4
K: Real estate, renting and business activities	10.1
O: Other community, social and personal service activities	6.3
Data not available	4.3

constructs of organizational learning culture and organizational performance we used a combined exploratory-confirmatory approach. We followed the paradigm applied by Koufteros (1999). First, data were subject to exploratory factor analysis (see Appendix B) which may provide some initial insight but does not provide an explicit test of unidimensionality (Gerbing & Anderson, 1988; Segars & Grover, 1993). In addition, we applied confirmatory factor analysis (CFA) using the LISREL 8.54 software package. We examined convergent validity and unidimensionality by examining the loading paths of all items, which should be statistically significant and exceed 0.50 (Hair, Anderson, Tatham, & Black, 1998; Prajogo & McDermott, 2005). In the iterative process of purifying the scales several items (measurement variables) were excluded from further analysis. In the final version of the model, 31 of 60 items were used to measure 10 constructs, four second-order factors and one first-order factor. Simple second-order models for each of the second-order factors Infoacq, Infoint, Bcc, and Innov were run prior to combining the constructs IA2, IIELEC, IIFACE, BC, CC, TI, and AI into the aggregates.

Discriminant validity is defined as the extent to which the measure is novel and not simply a reflection of some other construct or variable (Churchill, 1979). Discriminant validity is measured by pairwise correlations as proposed by Venkatraman (1989). Discriminant validity is indicated by low correlations between the measures of interest and other measures that are supposed to measure different constructs (Heeler & Ray, 1972; Venkatraman & Grant, 1986). Discriminant validity is accomplished when the correlation of a variable with another variable does not exceed 0.55 and is significant at $p < 0.05$ (Schwab, 1980). Besides, correlation should have the directions assumed by theory (Venkatraman, 1989).

A composite reliability index (CRI) and average variance extracted (AVE) were calculated to test for composite (construct) reliability (Fornell & Larcker, 1981). Composite reliability assumes that a set of latent construct indicators is consistent in the measurement. There is no generally acceptable standard for adequate values of CRI. Koufteros (1999) suggested values above 0.80, while Diamantopoulos and Siguaw (2000) were satisfied with 0.60. AVE is similar to CRI with the one exception that standardized loadings are squared before summing them (Hair et al., 1998; Koufteros, 1999). The cut-off value most often used for AVE is 0.50 (Bagozzi & Yi, 1988; Hair et al., 1998), while there are also cases where a milder restriction of 0.40 was employed (Diamantopoulos & Siguaw, 2000).

For the purposes of evaluating fit at the global level a plethora of fit indices exists. Research evidence supports the need to use more than one index (Bollen & Long, 1993; Breckler, 1990; Coenders, Casa, Figuer, & Gonzalez, 2003; Tanaka, 1993). χ^2 per degrees of freedom, comparative fit index (CFI) and non-normed fit index (NNFI; also named the Tucker–Lewis fit index: TLI) are used most often to assess model fit (Koufteros, 1999). The ratio χ^2 per degrees of freedom should not exceed 2, while models exhibiting CFI and

NNFI indices greater than 0.90 have an adequate fit. Some researchers (Coenders et al., 2003) even suggest a cut-off value of 0.95. We also have to stress the fact that the multivariate normality test showed the non-normal distribution of data for which a Satorra–Bentler χ^2 was used.

Finally, we used structural equation modeling (SEM) to test the structural relationships among constructs. We decided to use SEM for similar reasons as Prajogo and McDermott (2005): (1) to allow for the modeling of both observed and latent variables and (2) to test several structural relationships simultaneously. Specifically, the maximum likelihood (ML) method was used to estimate the parameter values. Even though several methods can be used for this purpose, ML is the one most frequently used and has the advantage of being statistically efficient and at the same time specification-error sensitive because it demands only complete data and does not allow for missing values. All methods will, however, lead to similar parameter estimates where the sample is large enough and the model is not misspecified (Jöreskog & Sörbrom, 1993). Overall coefficients of determination (R^2) are reported for each endogenous variable to explain the amount of variation in an endogenous variable explained by the proposed model.

5. Data analysis

5.1. Validity and reliability

The construct validity of each scale was assessed using CFA in order to establish how well the items measured the corresponding scales. In Table 3 we report unstandardized and completely standardized factor loadings together with corresponding t -values for each item and scale involved in the final solution of the measurement model. Nine more items were excluded from further analysis (following the 29 omitted after the preliminary exploratory factor analysis). In addition, constructs IA1, IA2, IA4, and IIEEXT were excluded from further analysis after performing second-order confirmatory factor analysis due to completely standardized factor loading values below 0.50. In the final model, all items and scales exceeded the threshold of 0.50 for convergent validity. In general, both unidimensionality and convergent validity were confirmed.

Analysis of second-order models for Infoacq, Infoint, Bcc, and Innov provided empirical justification for combining constructs IA2, IIELEC, IIFACE, BC, CC, TI, AI into aggregates. Fit indices for all four second-order models are satisfactory. All measurement variables are statistically significant related to constructs ($p < 0.05$) while the standardized loadings range from 0.51 to 1.00.

The values of the composite reliability index (CRI) as well as average variance extracted (AVE) are presented in Table 4 for all scales and constructs in the final measurement model. While all CRI values easily exceed the milder threshold for composite reliability (0.60), most of them also exceed the stricter criterion (0.80). The same can be said for AVE where values for all latent variables and scales (but two) exceed 0.50. The only exception is the scale information acquisition 2 (IA2, with AVE 0.47) and construct information interpretation (with AVE 0.49). Nevertheless, both were left in the model due to content considerations as well as very marginal discrepancies from the required threshold 0.50.

Discriminant validity tests (a matrix of Pearson's pairwise correlations for the initial 10 measurement variables) are presented in Table 5. The results indicate that discriminant validity is mostly achieved, with the exception of IIELEC that exhibits low correlations with two of the measurement variables included in the construct Iculture (with IC1 0.11 and with IC2 0.13). IC2 correlates strongly with IC3. AI correlates statistically significantly and strongly with BC and TI. Nevertheless, vast majority of the constructs satisfy this requirement for discriminant validity.

Table 3
Construct validity.

Second-order factors	Constructs	Measurement variables (items – final)	Unstandardized factor loadings		Completely standardized factor loadings		t-values	
Infoacq	IA2	A15	1.00	1.22	1.00	0.66	– ^a	6.00
		A111		1.00		0.57		– ^a
		A113		1.00		0.57		5.68
		A115		1.05		0.60		5.68
Infoint	IIELEC	A39	1.00	0.91	0.51	0.66	– ^a	5.26
		A310		1.00		0.72		– ^a
		A311		0.82		0.55		4.66
	IIFACE	A32	1.24	1.31	0.70	0.84	4.02	4.37
		A33		1.00		0.60		– ^a
Bcc	BC	A43	1.00	0.81	0.80	0.63	– ^a	7.85
		A44		1.00		0.78		– ^a
		A45		0.89		0.62		7.81
		A46		1.12		0.81		9.01
	CC	A48	1.05	0.82	0.58	0.67	7.29	2.59
		A49		1.00		0.76		– ^a
Iculture	IC1	B31	0.86	– ^b	0.76	– ^b	10.09	– ^b
	IC2	B32	1.00		0.85		– ^a	
	IC3	B35	0.93		0.79		11.91	
Innov	TI	B11	1.00	0.68	0.84	0.55	– ^a	7.76
		B12		0.87		0.75		12.40
		B13		0.91		0.74		14.45
		B14		1.00		0.82		– ^a
		B15		0.84		0.68		11.66
		B16		0.97		0.81		14.30
		B17		0.88		0.79		10.86
		B18		0.78		0.70		9.94
		B19		0.86		0.77		10.74
	AI	B21	1.18	0.74	0.91	0.75	13.33	12.18
		B22		0.62		0.58		9.02
		B23		0.85		0.77		13.31
		B24		1.00		0.81		– ^a

Fit indices: $\chi^2 = 149.74$ ($p = 0.00$), $df = 90$, $\chi^2/df = 1.66$, NNFI = 0.98, and CFI = 0.98.

^a Indicates a parameter fixed at 1.00 in the original solution.

^b First-order construct.

Table 4
Construct reliability.

Latent variable	Aggregate (average) of items	Number of items (final)	CRI	AVE		
Infoacq	IA2	4	1	0.78	1	0.47
Infoint	IIELEC	3	0.65	0.78	0.49	0.54
	IIFACE	2		0.79		0.66
Bcc	BC	4	0.75	0.81	0.61	0.51
	CC	2		0.78		0.64
Iculture	IC1	1	0.88		0.79	
	IC2	1				
	IC3	1				
Innov	TI	9	0.92	0.95	0.86	0.67
	AI	4		0.89		0.62

5.2. The relationship between organizational learning culture and innovativeness

As noted earlier, this research aimed to test the structural relationship between organizational learning culture and innovativeness. Organizational learning culture is a culture in which the process of information acquisition (Infoacq), information interpretation (Infoint), and behavioral and cognitive changes (Bcc) is highly valued. When information is acquired it needs to be interpreted and converted into action in order to be able to say that organizational learning has happened. This is the reasoning behind the sequential structuring of elements of an organizational learning culture. Organizational culture aiming at optimizing this process can be considered an organizational learning culture. It

covers both flexibility-oriented cultures (group and developmental) as well as hierarchical and rational cultures – in line with the competing values framework (Denison & Spreitzer, 1991; McDermott & Stock, 1999). Innovativeness was evaluated using constructs innovative culture (Iculture) and innovations (Innov).

The results of fitting the structural model to the data show that the model had a good fit as pointed out by $\chi^2/df = 1.97$, NNFI = 0.97, and CFI = 0.98. In Fig. 4 the path diagram of our model is presented. When examining the structural part of the diagram, standardized values of path coefficients are presented with t-values in brackets. Overall coefficients of determination (R^2) for each one of the endogenous constructs are 0.41 for Infoint, 0.93 for Bcc, 0.33 for Iculture, and 0.73 for Innov. This means that model explains variance in observed endogenous constructs very well. As mentioned in the research methods subsection, a mix of exploratory and confirmatory approaches was used for generating the model. The final goal was to set up a model that makes both theoretical sense and has a reasonable correspondence to the data (Bollen & Long, 1993; Jöreskog, 1993; McCallum, 1995; Prajogo & McDermott, 2005). From a substantive point of view, five relationships among constructs of interest were hypothesized. In the final version of the model all of them were found to be statistically significant at least at $p < 0.01$.

Valuing the acquisition of different information types leads to a better understanding and interpretation of the acquired information. The effect is strong (standardized value = 0.64), statistically significant ($t = 3.61$) and positive. Placing a high level of importance on various channels of information interpretation (face-to-face, electronic) leads to greater action in terms of behavioral and cognitive changes (effect = 0.96, $t = 3.68$), meaning that more learning has actually occurred.

Table 5
Discriminant validity.

Scale/construct	1	2	3	4	5	6	7	8	9	10
(1) IA2	1.00									
(2) IIELEC	0.28**	1.00								
(3) IIFACE	0.16*	0.36**	1.00							
(4) BC	0.43**	0.26**	0.34**	1.00						
(5) CC	0.36**	0.22**	0.26**	0.46**	1.00					
(6) IC1	0.30**	0.11	0.35**	0.27**	0.28**	1.00				
(7) IC2	0.38**	0.13	0.23**	0.23**	0.32**	0.67**	1.00			
(8) IC3	0.40**	0.16*	0.27**	0.35**	0.29**	0.58**	0.67**	1.00		
(9) TI	0.48**	0.26**	0.33**	0.53**	0.30**	0.42**	0.45**	0.45**	1.00	
(10) AI	0.49**	0.20**	0.21**	0.55**	0.44**	0.49**	0.53**	0.54**	0.76**	1.00

* Correlation is significant at the 0.05 level (two-tailed).
** Correlation is significant at the 0.01 level (two-tailed).

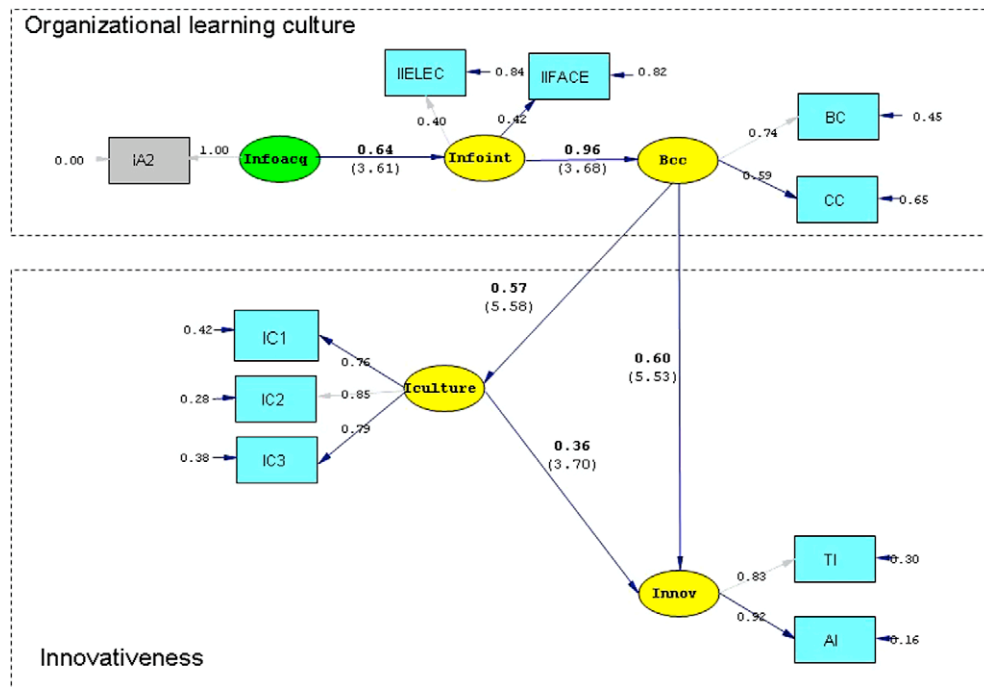


Fig. 4. The model of relationships among organizational learning culture and innovativeness constructs.

The behavioral and cognitive changes construct has a statistically significant, positive and strong effect on both aspects of innovativeness included in the model. This effect is a bit stronger directly on technological and administrative innovations (0.60, $t = 5.53$), while it is also strong on innovative culture (0.57, $t = 3.70$). The effect of innovative culture on technological and administrative innovations is moderately strong in size (0.36) and still positive and statistically significant ($t = 3.70$).

Obviously, positive effects of attaining an organizational learning culture in terms of augmented administrative and technical innovations emerge both directly as well as indirectly via innovative culture. This is evident from the decomposition of effects seen in Table 6. All elements of organizational learning culture (Infoacq, Infont, and Bcc) have a statistically significant (very) strong indirect effect on innovations.

6. Discussion and implications

Hypotheses 1 and 2 show that organizational learning is indeed a process in which information as a raw material is transformed

into action. Organizations that value systematic approaches to organizational learning thus stress the importance of acquiring all types of information (operational, tactical and strategic) from both internal and external sources. The better a certain firm is at acquiring information the more understanding it can get from it. In other words, information acquisition positively effects information interpretation, which is nothing other than the ability to recognize entrepreneurial opportunities. Behavioral and cognitive changes mean transforming words into actions and seizing these opportunities, which wraps up the organizational learning cycle. Firms that attribute a high level of importance to the elements of this process integrate them into their set of norms and values and may be considered to have an organizational learning culture (Škerlavaj et al., 2007).

The paper has shown that an organizational learning culture does have an impact on innovativeness. Specifically, we found that an organizational learning culture has a direct impact on technical and administrative innovations (Hypothesis 5). Organizational learning culture also has moderate indirect positive effect on innovations via innovative culture (Hypotheses 3 and 4). Each of these findings might help to illuminate the effectiveness

Table 6
Decomposition of effects.

Path	Unstandardized coefficients (t-values)			Standardized coefficients		
	Total effects	Direct effects	Indirect effects	Total effects	Direct effects	Indirect effects
Infoacq–Infoint	0.21(3.68**)	0.21(3.68**)	–	0.64	0.64	–
Infoacq–Bcc	0.37(8.61**)	–	0.37(8.61**)	0.61	–	0.61
Infoacq–Iculture	0.37(6.86**)	–	0.37(6.86**)	0.35	–	0.35
Infoacq–Innov	0.35(7.86**)	–	0.35(7.86**)	0.49	–	0.49
Infoint–Bcc	1.76(3.61**)	1.76(3.61**)	–	0.96	0.96	–
Infoint–Iculture	1.77(3.51**)	–	1.77(3.51**)	0.55	–	0.55
Infoint–Innov	1.69(3.71**)	–	1.69(3.71**)	0.77	–	0.77
Bcc–Iculture	1.00(5.58**)	1.00(5.58**)	–	0.57	0.57	–
Bcc–Innov	0.96(7.61**)	0.72(5.53**)	0.24(3.28**)	0.81	0.60	0.21
Iculture–Innov	0.24(3.70**)	0.24(3.70**)	–	0.36	0.36	–

* $p < 0.01$.

** $p < 0.001$.

and efficiency of the organizational learning culture's application to workplace innovation in Korean companies that are facing unpredictable global and economical challenges. Heo (2008) argued that organizational learning culture depends on the acquisition of information, the interpretation of information, and the creation of organizational knowledge. In other words, the learning culture can result in maximizing the capability of innovation in a high performance organization. Furthermore, according to Chang (2008), firm's innovation was significantly accounted by organizational learning culture and positively influenced by the interaction between the type of organizational learning and environmental uncertainty. The result of this research could provide acceptable rationales and enhance the reliability of current research.

This study has major managerial implications. There is a substantial consensus today that a key competitive advantage of organizations lies in their ability to learn and to be responsive to challenges from both internal and external business environments (Škerlavaj et al., 2007). Clearly, more attention has to be paid to developing an organizational learning culture in order to improve organizational innovativeness. This can be achieved by cultivating an environment in which the employees can and should continually learn and share their knowledge. One practical implication of this thinking is that investing effort, time and money into initiatives aimed at developing a learning-oriented culture can bring about augmented innovativeness within modern organizations. Korea is no exception to this finding. Since the severe economic crisis in 1997, most of Korean organizations have more focused on the organizational innovation in terms of structural innovation, process innovation, and so on (Lim & Kah, 2004). This research would provide theoretically acceptable, which is also practically applicable, flow-map for building strategic organizational innovation-related initiatives for Korean (and other) organizations.

The focus of learning-oriented culture in organizational innovation must meet the dynamic requirements of the workplace, some of which cannot be anticipated. Thus the organizational learning culture must be flexible in that it entertains further changes in workplace demands, that learning support is updated in a timely manner, and that it helps employees in organization adapt themselves in substantial change of external environment. New principles introduced in the organizational learning culture should be conditioned with advisement that they might be superseded in the future by the unanticipated changes in workplace demands. Employees in flexible organizational learning culture should be advised that changes in economic, political, and corporate structures could significantly alter the way of innovation in the workplace and might be required to change the fundamental process by which work is done and prepare for a new career.

In terms of implications for researchers, turning to the assumptions of the competing values model (Denison & Spreitzer, 1991), our research confirms findings from Škerlavaj et al. (2007). That is, in reality, firms are combinations of all four ideal types of cultures. It is true that in an organizational learning culture group and developmental cultures are predominant. Still, hierarchical and rational cultures are present to some extent. While a flexibility orientation is considered as offering responses to most challenges in the modern business environment this is not necessarily always so. Besides innovation and creativity and openness and commitment, firms need some structure, stability and continuity while not neglecting the fact that they also have to be accomplishment-oriented.

The cross-sectional nature of the data gathered imposes the first methodological limitation – the inability to directly draw conclusions through a causal inference. Even though the structural equation models are conceptualized in a causal way, this technique needs to be backed up in advance with theoretical assumptions and previous research findings. For instance, in our case it might also be the case that superior innovativeness backs up the attainment of a higher-level organizational learning culture. For this reason, other research designs such as experimental and longitudinal ones are desirable when examining causal relationships among organizational variables (Egan et al., 2004). Such designs are extremely rare in this research context, whereas problems with data gathering (e.g. small overlaps of samples among different years, respondent non-disclosure, etc.) occur on a regular basis. Nevertheless, Hult, Ketchen, and Slater (2002) did one similar study by conducting a longitudinal study of the learning climate on cycle times in supply chains.

Every researcher and manager dealing with organizational culture and business process change needs to be aware of the multiplexity and multiple dimensions of organizational culture (Schein, 1992; Trompenaars & Woolliams, 2003). Further, the existence of different kinds of subcultures within organizations also needs to be accounted for. Besides, organizational culture is also heavily intertwined with national culture and other contextual variables (Hofstede, 1980), which will all need to be considered in future research. In addition, based on the primary objective of the current research, complicated organizational behavior-related interactions could be more accurately captured through in depth-observation of the phenomenon in the workplace. In future research, longitudinal studies with a more qualitative-oriented approach using in-depth case studies are recommended. This would yield a deeper understanding of the relationship of the constructs proposed in our model and serve to further test its applicability and usefulness from the practical point of view.

Appendix A. List of measurement items

A. Organizational learning	
<i>A.I. Information acquisition</i>	
1.	Employees in our organization are an extremely important source of information
2.	Previous decisions are a very useful source of information for current decisions
3.	New business methods and services are always worth trying even if they may prove risky
4.	Reports prepared by external experts are an extremely important source of information
5.	Our organization uses clipping service – regular collection of papers and articles to our interest
6.	Our competitors are an extremely important source for learning new methods and services
7.	Expertise on the industry, products, and services is an extremely important criterion for hiring a new employee
8.	Joint tasks and mergers contribute a great deal of knowledge about industry and economic environment, new methods and services/products
9.	Top managers in any important decision seek information or advice from the board of directors or owners (in general)
10.	Top managers in any important decision seek information or advice from sources outside the company (hiring experts, contacting top managers of other companies, etc.)
11.	Our organization has employees whose job is related to searching for external information
12.	External sources (reports, consultants, newsletters, etc.) are extremely important for the operations of our organization
13.	In our organization we explicitly reward employees that are a source of quality information
14.	In our organization we often organize internal training of our employees
15.	We frequently send our employees to various seminars, workshops, conferences with intention to acquire information
<i>A.II. Information interpretation</i>	
1.	Personal contacts
2.	Team meetings
3.	Committees as decision-makers
4.	Telephone contacts
5.	Seminars, conferences, workshops
6.	Written memos, notes, letters...
7.	Special expert reports
8.	Formal chain of command reporting (in sense of reporting to superiors)
9.	Companies intranet as a mean of information interpretation
10.	Forums (e-chat, e-debates)
11.	Electronic e-mail
12.	The more information the subordinate has the better he/she will perform
13.	Information to a subordinate must always be simple and concise
<i>A.III. Behavioural and cognitive changes</i>	
1.	Adaptability to environmental pressures
2.	Quality of products/services

Appendix A. (continued)

A. Organizational learning	
3.	Number of products/services offered
4.	Technology of operation
5.	Speed of operations
6.	Introduction of new marketing approaches
7.	Average productivity of employees
8.	Satisfaction of employees
9.	Overall atmosphere
10.	Personal communication between top managers and employees
11.	Team meetings' efficiency
12.	Employees' level of understanding of company's strategic orientation
13.	Employee's level of understanding of major problems in the company
14.	Efficiency of information systems within the company
B. Innovativeness	
<i>B.I. Product and service (technical) innovations</i>	
1.	In new product and service introduction, our company is often first-to-market
2.	Our new products and services are often perceived as very novel by customers
3.	New products and services in our company often take us up against new competitors
4.	In comparison with competitors, our company has introduced more innovative products and services during past 5 years
5.	We constantly emphasize development of particular and patent products
6.	We manage to cope with market demands and develop new products quickly
7.	We continuously modify design of our products and rapidly enter new emerging markets
8.	Our firm manages to deliver special products flexibly according to customers' orders
9.	We continuously improve old products and raise quality of new products
<i>B.II. Process (administrative) innovations</i>	
1.	Development of new channels for products and services of our corporation is an on-going process
2.	We deal with customers' suggestions or complaints urgently and with utmost care
3.	In marketing innovations (entering new markets, new pricing methods, new distribution methods, etc.) our company is better than competitors
4.	We constantly emphasize and introduce managerial innovations (e.g. computer-based administrative innovations, new employee reward/training schemes, new departments or project teams, etc.)
<i>B.III. Innovative culture</i>	
1.	Innovation proposals are welcome in the organization
2.	Management actively seeks innovative ideas
3.(R)	Innovation is perceived as too risky and is resisted
4.	People are not penalized for new ideas that do not work
5.	Program/project managers promote and support innovative ideas, experimentation and creative processes

Appendix B. Results of exploratory factor analysis

B.1. Information acquisition

Varimax-rotated factor loadings.

	Factor			
	1	2	3	4
a111	0.718	0.090	0.187	-0.136
a113	0.697	-0.069	0.114	-0.081
a114	0.697	-0.087	0.016	0.401
a15	0.662	0.289	-0.064	0.101
a115	0.632	0.070	0.177	0.443
a16	0.064	0.730	0.131	-0.169
a14	-0.108	0.624	0.132	0.206
a13	0.104	0.618	-0.065	0.224
a18	0.111	0.506	0.359	0.295
a112	0.369	0.451	0.258	0.084
a110	0.200	-0.047	0.719	0.147
a19	0.083	0.141	0.716	0.058
a17	0.001	0.387	0.590	-0.093
a12	-0.086	0.095	0.178	0.776
a11	0.202	0.198	-0.051	0.687

Factor 1: a15, a111, a113, a115 – IA1.

Factor 2: a13, a14, a16, a18 – IA2.

Factor 3: a17, a19, a110 – IA3.

Factor 4: a11, a12 – IA4.

Out: a114, a112.

Please note: after CFA items a14, a13, a12, a16 were additionally omitted from further analysis.

B.2. Information interpretation

	Factor		
	1	2	3
a310	0.794	0.016	0.158
a311	0.708	0.068	0.058
a39	0.662	0.295	-0.084
a34	0.504	0.462	-0.108
a33	0.078	0.818	-0.121
a32	0.200	0.741	0.192
a31	0.000	0.548	0.409
a36	0.443	0.547	0.170
a38	0.342	0.252	-0.710
a35	0.287	0.274	0.610
a37	0.373	0.199	0.440

Factor 1: a39, a310, a311 – Electronic II: IIELEC.

Factor 2: a33, a32 – Group face-to-face II: IIFACE.

Factor 3: a35, a37 – External II: IIEEXT.

Out: a34, a31, a36, a38.

B.3. Behavioral and cognitive changes

	Factor	
	1	2
a49	0.863	0.180
a48	0.825	0.180
a410	0.763	0.302
a411	0.738	0.254
a47	0.619	0.443
a413	0.558	0.479
a412	0.548	0.448
a44	0.169	0.818
a43	0.107	0.808
a42	0.347	0.696
a45	0.278	0.687
a46	0.365	0.625
a414	0.420	0.564
a41	0.383	0.480

Factor 1: a48, a49, a410, a411 – Cognitive changes: CC.

Factor 2: a42, a43, a44, a45, a46 – Behavioral changes: BC.

Out: a41, a47, a412, a413, a414.

Out after CFA: a411, a42, a410.

B.4. Innovative culture

	Factor 1
b32	0.859
b35	0.841
b31	0.840
b34	0.522
Recoded b33	0.377

Factor 1: b31, b32, b34, b35 – Innovative culture: IC.

Out: recoded b33.

Out after CFA: b34.

B.5. Technical (product and service) innovations

	Factor 1
b14	0.849
b16	0.826
b17	0.823
b19	0.805
b12	0.781
b13	0.772
b18	0.721
b15	0.719
b11	0.594

Factor 1: all nine items.

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