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What organizational culture types enable and retard open innovation?

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Abstract Research suggests that cultural issues can make or mar the open innovation process. In this paper, we thus aim at identifying organizational culture types that enable and retard the two types of open innovation activities: in-bound and out-bound. Data were collected using the questionnaire survey method from 339 middle and top managers working in the Malaysian high-tech sector. Organizational culture emerged as a huge predictor of open innovation. We found that highly integrative culture enables in-bound open innovation, but does not significantly affect out-bound open innovation. Besides, hierarchy culture is found to retard both in-bound and out-bound open innovation. This paper is probably the first to empirically investigate the role of culture in open innovation. The findings fill an important gap in open innovation theory while practical implications extend to managers interested in open innovation adoption in their organizations.

Keywords Organizational culture · Open innovation · High-tech industries · Malaysia

1 Introduction

Open innovation (Chesbrough 2003) has continued to be a buzzword in management literature since this phrase was coined in the early years of this century. With the related literature growing, many advantages of open innovation have been highlighted (Vanhaverbeke et al. 2008; Ili et al. 2010; Van de Vrande et al. 2009). However, advantages of open innovation apart, being a part of the open innovation paradigm and reaping its benefits does not seem to be easy. Many barriers—such as lack of resources, free-riding behaviour, and problems with contracts—exist in the way of effective collaboration between

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firms (Mohr and Spekman 1994; Hoffmann and Schlosser 2001). Corroborating this view, more recent research too has shown that several challenges accompany the open innovation process, making embracing this model of innovation difficult (Naqshbandi and Kaur 2014).The current body of literature on open innovation (Boschma 2005; Carbone et al. 2010; Lichtenthaler 2011; Van de Vrande et al. 2009) highlights organizational culture as one such major challenge. This is because a favorable organizational culture allows an organization to address ever-changing problems of adaptation to the external environment and the internal integration of organizational resources, personnel and policies to support external adaptation (Pool 2000); facilitate open innovation adoption (Van de Vrande et al. 2009); and make collaborations effective (Boschma 2005). This implies that, among other factors, an unfavourable culture can cause problems in collaborations (Van de Vrande et al. 2009). However, despite the current literature rightly identifying organizational culture as a challenge, surprisingly, it is unclear as to what type of organizational culture enables open innovation, or retards it. This unclarity could be attributed to the infancy of open innovation research (West et al. 2006), thereby leaving pending a clear and 'fruitful avenue' for further theoretical and empirical research (Lichtenthaler 2011).

Motivated thus, we examine the role of organizational culture in open innovation in the Malaysian high-tech sector. Specifically, the objective is to identify organizational culture types that enable and retard open innovation.

This paper provides empirical evidence regarding the relationship between organizational culture and open innovation in a developing country setting, Malaysia. The data, collected in 2012, come from the high-tech sector in Malaysia. In the Asian context, a few open innovation studies have emerged (cf. Abulrub and Lee 2012; Naqshbandi and Kaur 2011a), however not much is documented about open innovation activities in Malaysia (Lindegaard 2012), more so in the high-tech industry which contributes substantially to the Malaysian economy. We choose the high-tech sector because, apart from its vital contribution to the Malaysian economy, the industries in this sector are primarily knowledge-driven industries (Hatzichronoglou 1997), and since open innovation is rather a new concept, particularly in the Asian context, the adoption of open innovation is expected to be higher among high-tech industries than in asset-intensive mature industries. In addition, we choose to conduct this study in Malaysia because it is regarded as one of the most promising countries for open innovation in Asia due to its potential to become the open innovation hub in Asia (Lindegaard 2012). Malaysian business leaders understand this potential. Thus, recognizing the benefits of open innovation, one top Malaysian executive, Dr Roger Wyse, Co-chairman/director of the Malaysian Life Sciences Capital Fund (MLSCF) exhorted Malaysian companies to adopt the open innovation model to create more investment opportunities and stimulate economic growth of the country by leveraging internal and external sources of ideas (Bernama October 25, 2011).

In addition to contributing by filling the gap in current open innovation theory (Lichtenthaler 2011), the findings of this paper would help practitioners nurture and avoid the organizational culture types that enable and retard open innovation respectively. An understanding of the findings can also help firms predict, based on their organizational culture, whether they should embark on an open innovation journey or ensure first that their organizational culture is conducive for the open innovation model.

2 Theoretical background and hypothesis development

2.1 Open innovation

Since the 1990s, relentless competition has forced firms to constantly adapt, renew, reconfigure and re-create their resources and capabilities in line with the changing competitive environment (Teece 1992; Teece et al. 1997). As a result of rapid technological changes taking place and other factors of globalization, sticking to the traditional closed innovation model (West et al. 2006) can lead to loss of competitive advantage for a firm. As against this, embracing the open innovation model can result in important strategic innovations providing firms with competitive advantage (Naqshbandi and Kaur 2011b). Chesbrough (2003) defined open innovation as *"the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively"*.

In the open innovation model, consistent with the notion of dynamic capabilities (Teece et al. 1997), the firm boundaries become porous and there is more interaction between partner firms that results in greater technology acquisition and exploitation (West et al. 2006). Consequently, greater amounts of resources and expertise are at hand than expected in the closed innovation model. Adopting thus an external knowledge strategy such as the open innovation model offers many benefits and creates a heady mix of talent and expertise which often stimulates and leads to faster innovation.

Research has identified two main types of open innovation: in-bound open innovation and out-bound open innovation. In-bound or outside-in open innovation refers to the use of discoveries that others make and involves opening up to and establishing relationships with external firms with the aim to access their competencies in order to enhance the firm's innovation performance. It implies purposive inflows of knowledge or technology exploration relating to innovation activities aimed at capturing and benefiting from external sources of knowledge to enhance current technological developments. On the other hand, out-bound or inside-out dimension implies that firms can search for external players that have better fitting business models to exploit and commercialise a particular technology than just depend on internal paths to market (Vanhaverbeke 2006). It refers to the purposive outflows of knowledge, or technology exploitation, meant to leverage existing technological capabilities outside the boundaries of the organization. The external exploitation of ideas can happen in different markets by selling intellectual property rights and multiplying technology by diverting ideas to the external environment (Gassmann and Enkel 2004).

2.2 Organizational culture

Of the early writings on organizational culture, Pettigrew's (1979) work stands out. Since this work, a large number of studies have piled up, defining and explaining the concept of organizational culture in different ways. Consequently, organizational culture has been defined differently by a multitude of scholars (Ott 1989; Schein 1990; Hofstede et al. 1990; Keesing 1974; Schein 1993; Denison 1990). An oft-cited definition of organizational culture is given by E. H. Schein who defined organizational culture as: "*a pattern of basic assumptions that the group learned as it solved its problems of external adaptation and internal integration, that has worked well enough to be considered valid and, therefore, to be taught to new members as the correct way to perceive, think, and feel in relation to those problems*" (Schein 1992). This definition of organizational culture focuses on external adaptation and internal integration aspects of a firm's culture which are in turn based on five cultural values namely: employee development, harmony, customer orientation, social responsibility and innovation (Tsui et

al. 2006). Of the five values that can be prevalent in an organization, the first two, employee development and harmony represent the internal integration aspect of organizational culture while the latter three, customer orientation, social responsibility and innovation represent the external adaptation aspect of organizational culture. Researchers recommend the use of a configurational approach in studying organizational culture, which takes a holistic view and emphasizes simultaneity and interaction among multiple causes of any outcomes (Tsui et al. 2006; Meyer et al. 1993). Such a configurational approach, one that is adopted in this study, presents the five organizational values highlighted above on a continuum – ranging from highly integrative culture (highest focus both on internal integration and external adaptation) to hierarchy culture (least focus on all the five culture dimensions) (Tsui et al. 2006).

2.3 Hypothesis development

Collaborations with external players entail complexities (Zahra and George 2002). In open innovation, such collaborations involve not only focus on the internal aspects of an organization, but greater attention to the external factors is also required (Thorelli 1986; Van de Vrande et al. 2009). Pool (2000) suggested that organizational culture can help an organization by allowing it to address ever-changing problems of adaptation to the external environment and the internal integration of organizational resources, personnel and policies to support external adaptation. Culture has rightly, therefore, been cited as a major challenge to open innovation adoption (c.f. Huston and Sakkab 2006; Verbano et al. 2011).

Innovation by definition deals with uncertain problems (Dasanayaka 2009), more so in the case of firms adopting open innovation as such firms face a higher degree of uncertainty in terms of exploration for better partners and outcomes of such partnerships. In such situations, organizational culture can help. Van de Vrande et al. (2009) found in the case of Dutch SMEs that managerial and organizational barriers to open innovation are related to organizational and cultural issues which arise when firms start to interact and collaborate with external partners. They found that such issues are encountered in a range of innovation activities, including venturing, customer involvement, external networking, R&D outsourcing and external participations. Introducing the open innovation paradigm in an enterprise requires not just a modification of the corporate process of innovation but also a cultural change (Carbone et al. 2010). This might be necessitated due to the involvement of foreign partners in the open innovation process. Therefore, organizational culture can enable or retard the open innovation process depending on whether an organization's culture is favourable or unfavourable to such a process.

Organizations with integrative cultures possess widely shared and strongly held values that address a firm's needs of internal integration and external adaptation. Such organizations with integrative cultures emphasize the values of caring for employees, customers, and the society in addition to emphasizing high standards for performance, innovation and responsiveness to changes in the external environment (O'Reilly et al. 1991; Tsui et al. 2006). According to Denison and Mishra (1995) organizations that care for their customers and are socially responsible tend to be more flexible in dealing with changes in the environment and directing employees towards fulfilling their objectives. Organizations with integrative culture unite employees by promoting their aspirations to succeed, instilling a purpose for work, and strengthening their involvement with the organization (Chatman and Jehn 1994). In turn, employees in organizations with such a culture reciprocate with high levels of affective commitment, task performance, and citizenship behaviors. It must be noted that firms with an integrative culture pay equally high attention to employee development and harmony

(facilitating thereby internal integration) and customer orientation, social responsibility and innovation (facilitating external adaptation) (Schein 1992; Tsui et al. 2006).

Ahmed (1998) stated that possessing positive cultural characteristics can help an organization innovate and that culture could enhance or inhibit innovation. Looking at the issue from a practitioner's view-point, Phillips (2007) stressed that (an unfavorable) organizational culture can be an unlikely yet powerful barrier to innovation. As a result, for innovation to succeed, the culture of an organization must be dynamic enough to accommodate risk and uncertainty (Phillips 2007). Concurring with the need for this organizational dynamism, Khazanchi et al. (2007) stated that innovation requires flexibility, empowerment, control and efficiency, all at the same time. Their research goes on to corroborate some of the past studies that have established this view of innovation-supportive culture. In view of this discussion and since organizational culture is known to support the internal integration of organizational resources and adaptation to the external environment (Pool 2000), we hypothesize that:

Hypothesis 1 (H1) Highly integrative organizational culture relates positively to in-bound open innovation.

Hypothesis 2 (H2) Highly integrative organizational culture relates positively to out-bound open innovation.

In contrast to the above, organizations having a hierarchy culture do not emphasize cultural values, which organizations with integrative culture do, when dealing with customers and society (Cameron and Freeman 1991). Organizations with such a hierarchy culture focus least on all the five organizational culture values referred to above (Tsui et al. 2006). Organizations with a hierarchy culture achieve goals through formal rules and close supervision rather than through shared values. There is very little participation in decision making and employees are expected to follow standard operating procedures and rules. Under these circumstances, the employees are psychologically detached from the organization. They are unwilling to contribute much beyond basic task performance, exhibit low organizational citizenship behavior and care less about an innovative endeavor. As a result, hierarchy cultures have been found to promote imitation strategies (Naranjo-Valencia et al. 2011). Also, traditional cultures, which are more inward-looking like the hierarchy culture, are often seen as a barrier for a more open approach that open innovation involves (Golightly et al. 2012). Hierarchy culture in firms is thus expected to impede open innovation because such a culture focuses least on internal integration of the organizational resources and adaptation to the external environment of a firm, emphasis on which is important for the success of open innovation. In light of this, we hypothesize that:

Hypothesis 3 (H3) Hierarchy organizational culture relates negatively to in-bound open innovation.

Hypothesis 4 (H4) Hierarchy organizational culture relates negatively to out-bound open innovation.

3 Methodology

3.1 Sample and procedures

Choosing a firm's most suitable respondents is of utmost importance to innovation surveys. This is because the questions are very specialized and can be properly answered by only a

few people in the firm. According to Oslo Manual (2005), Managing Directors are often good respondents for innovation surveys in small firms, while in larger firms, several people can be appropriate respondents. We kept these guidelines in view and surveyed middle and top managers working in Malaysian manufacturing firms operating in four industries classified as high-tech: Aerospace, Computers and office machinery, Electronics and communication, and Pharmaceuticals (OECD 1997). Middle managers and top managers were chosen because of their know-how of the strategic direction of their firms.

Although innovation activities take place in all parts of an economy—in manufacturing, the service industries, public administrations, the health sector and even private households—in reality, for various theoretical and practical reasons, a survey cannot cover all possible units. This is because the concept of innovation may be less clear in some parts of the economy, especially for non-market-oriented activities (Oslo Manual 2005). In line with this, we chose the manufacturing sector, as opposed to the services sector, because the incidence and adoption of Open Innovation are anticipated to be stronger in the manufacturing sector (Van de Vrande et al. 2009). According to Gassmann (2006), industries characterized by globalization, technology intensity, technology diffusion, new business models and knowledge leveraging are more prone to Open Innovation adoption; and Van de Vrande et al. (2009) suggest that these characteristics are more applicable to manufacturers than service enterprises.

The data for this study were collected over a five-month period from January 2012 to May 2012. The respondents were required to have served the same organization for at least five (5) years and the responding firms were required to have a Research and Development (R&D) department and only the firms that met this requirement were approached (Oslo Manual 2005). We used a two-stage sampling procedure (Davis 2005) involving stratified sampling and convenience sampling techniques. In the first stage, stratified sampling was used and the high-tech industry was sub-divided into four (4) industries. In the second stage, convenience sampling was used to select firms from the four industries. Two sampling frames were used. The first sampling frame was taken from Malaysian Manufacturers' Directory (2011). In addition, a Pharmaceutical exposition held in Kuala Lumpur from April 17–19, 2012 provided an opportunity to the researcher to collect more data from the Malaysian pharmaceutical companies. After ensuring that firms in the exposition met the sampling constraints delineated above, the researchers administered the questionnaire on a random basis. The second sampling frame of this study involved the fourth high-tech industry, the Aerospace industry and was taken from the Aerospace Industry Report (AIR) Online Database.

We first contacted the managers/firms telephonically and fixed appointments for questionnaire distribution and/or any necessary explanation about the questionnaire and research project in general. During the first meeting, meetings were fixed with the firms/managers for collection of the questionnaires. Before collection of the questionnaires, the researchers again contacted the respondents to ensure a smooth collection of the questionnaires. In total, 900 questionnaires were distributed by email and in person; 366 were returned from 139 firms—68 by email and 298 in person. As suggested by Hair et al. (2010), the questionnaires that had more than 10 % missing values were discarded. No questionnaires received electronically had missing values, apparently because the electronic questionnaires prompted the respondents to answer all the questions before submitting. On the other hand, all the discarded questionnaires, 27 in number, were those that were collected in person from the respondents. In total, 339 usable responses, from 133 firms, were considered 'clean' and thus used in further data analysis. The response rate thus achieved in this study is 37.66 %, which can be considered decent given some recent similar studies in the Asian context (e.g. Abulrub and Lee 2012, response rate: 7 %).

3.1.1 Respondent profile

Of the sample, 30.4 % belonged to the Pharmaceutical industry while to the Computers and Office Machinery industry, the Electronics and Communications industry and the Aerospace industry belonged 25.7, 22.4 and 21.5 % respondents respectively. 54.9 % of the respondents were in top management positions while roughly half the number of respondents (45.1 %) occupied middle management positions. 64.0 % respondents of this study had served the 'current' organization for 5–10 years while 28 % had worked in the same firm for 11–15 years, 7.1 % for 16–20 years and 0.9 % for above 20 years respectively. A majority 42.2 % of the surveyed firms operated globally while 31.9 and 26 % operated regionally and locally respectively. 47.5 % of the firms were privately-owned, 32.4 % had foreign ownership, 7.7 % were publicly-owned, 7.7 % had mixed ownership while 4.7 % were state-owned. Nearly half of the firms (45.1 %) surveyed for this study had been operating for 11–20 years while 25.7 %, had been operating for 21–30 years, 21.2 % for 31–40 years, 6.5 % for 1–10 years and a minuscule 1.5 % for above 50 years. As far as the size of the surveyed firms is concerned, the majority (40.4 %) had 101–500 employees while 35.7 % of the firms had 501–1,000 employees. Only 15.3 % of the surveyed firms can be considered small with less than 100 employees, while 7.7 and 0.9 % of the firms were quite large with 1,001–5,000 and above 5,000 employees, respectively.

3.1.2 Non-response bias

Problems due to non-response bias (Boström et al. 1993) may lead to an inappropriate interpretation of the measured phenomena. We thus were ruled out presence of such a bias by comparing means of the first and the last 40 respondents of this study. t-test was used to examine if any significant differences were present in the mean variable scores between the early and the late respondents. Absence of any such significant differences indicated absence of non-response bias in this study.

3.1.3 Common method bias

We took precautions to reduce any potential effects of common method bias and common method variance. Questionnaire items were thus mixed up and psychological separators were inserted between them. Additionally, we used Harman's single factor test to assess method bias (Podsakoff et al. 2003). To conduct Harman's single factor test, exploratory factor analysis (EFA) was performed on all the questionnaire items with the number of factors constrained to 1 and the unrotated solution was analyzed. The results of the EFA showed no sign of a single factor explaining majority of the variance (presence of which suggests method biases), indicating hence that the data is free from common method bias.

3.1.4 Control variables

Prior innovation research has considered differences between firms within an industry or sector, and also the differences between industries or sectors (West et al. 2006). We thus used industry type as a control variable because of its possible effects on open innovation. A one-way ANOVA conducted to compare in-bound and out-bound open innovation showed significant difference among four industries with respect to in-bound open innovation ($F = 14.38,\ p < .000$) and out-bound open innovation ($F = 137.42,\ p < .000$). Hence dummy variables were created to control for the effects of industry type.

3.2 Measurements

3.2.1 Organizational culture

Organizational culture has been evaluated along many dimensions and this has resulted in models and theories which are conceptually different but fundamentally similar (Yiing and Ahmad 2009). In this research the dimensions as proposed by Tsui et al. (2006) are used to capture organizational culture in the respondent firms. Tsui et al.'s (2006) five dimensions of organizational culture, based on the definition of Schein (1992) are: employee development, harmony, customer orientation, social responsibility and innovation. Employee development, harmony and customer orientation are measured using five items each while social responsibility and innovation are measured using four items each. In total twenty-three (23) items measure organizational culture in this study. All the items are anchored on a 5-point Likert scale ranging from "strongly disagree" to "strongly agree".

3.2.2 Open innovation

In-bound open innovation was measured using six items (6) taken from the scale developed by Sisodiya (2008). Out-bound open innovation was measured using four (4) items taken from previous studies (Jaworski and Kohli 1993; Lichtenthaler 2009). Items for both the dimension of open innovation were anchored on a 5-point Likert scale ranging from "strongly disagree" to "strongly agree". Please refer to Appendix 2 for a copy of the questionnaire.

3.3 Reliability and validity of the measures

3.3.1 Pilot-study

Questionnaires were distributed among post-graduate students with previous work experience registered in three faculties of the University of Malaya in Kuala Lumpur. Many of the respondents—coming from the Faculty of Business and Accountancy—were registered as MBA students and were full-time working professionals pursuing their MBA in an executive program as part-time students. Researchers have in the past too used MBA students successfully for pretests (for instance: Atuahene-Gima and Murray 2004; Frels et al. 2003; Sisodiya 2008). Through this exercise, conducted online, we were able to collect sixty-three (63) responses. We found that the respondents were generally comfortable answering all the questions. A few respondents suggested some minor changes which, after careful thought, were incorporated in the final version of the questionnaire. Reliability of the instrument was examined based on the collected data by assessing Cronbach's alpha which was found to be above .80 for all the variables. This affirmed reliability of the measurements used in this study (Hair et al. 2010).

3.3.2 Exploratory factor analysis (EFA)

The constructs investigated in this study have not been previously tested in Malaysia. Therefore, to gain an understanding of the underlying structure of the data (Pitt and Jeantrout 1994) and to examine factor loadings of all the items measuring the constructs, we first conducted EFA using principal component analysis as the extraction method and Varimax with Kaiser Normalization as the rotation method. Next, we took a confirmatory approach and performed confirmatory factor analysis (CFA) for all the variables of interest.

Table 1 EFA of organizational culture

Items	Factors					Item-total-correlation	Cronbach's alpha
	1	2	3	4	5		
OC.EmpDev.2	0.586					0.620	0.834
OC.EmpDev.3	0.715					0.752	
OC.EmpDev.4	0.743					0.708	
OC.EmpDev.5	0.754					0.585	
OC.Harmony.2		0.703				0.684	0.831
OC.Harmony.3		0.737				0.704	
OC.Harmony.4		0.670				0.630	
OC.Harmony.5		0.640				0.621	
OC.CustOrient.1			0.698			0.583	0.796
OC.CustOrient.2			0.752			0.666	
OC.CustOrient.3			0.750			0.618	
OC.CustOrient.5			0.692			0.564	
OC.SocRes.2				0.776		0.546	0.835
OC.SocRes.3				0.851		0.834	
OC.SocRes.4				0.722		0.730	
OC.Innov.1					0.693	0.658	0.849
OC.Innov.2					0.787	0.725	
OC.Innov.3					0.827	0.746	
OC.Innov.4					0.730	0.638	
Variance Explained	14.69	14.02	11.97	11.48	10.76		
Eigen value	8.50	1.82	1.58	1.50	1.07		

3.3.2.1 Organizational culture EFA of organizational culture, measured using 23 items, formed five factors. These five factors were consistent with the seminal study of Tsui et al. (2006) which also found five factors of organizational culture in the Chinese context. However, four items measuring this construct were eliminated because they did not contribute to a simple factor structure and failed to meet the minimum criterion of having factor loading of 0.5 or above (Hair et al. 2010). EFA conducted again without these 'offending items' revealed cleaner factors. The five factors, explaining together 62.93 % of the variance with Eigen value of more than 1, are labeled as: employee development, harmony, customer orientation, social responsibility and innovation. The Kaiser–Meyer–Olkin (KMO), a measure of sampling adequacy was found to be an acceptable 0.89 while Bartlett's Test of Sphericity was found to be significant ($\chi^2 = 3895.97$, $p < .001$). All the five factors were highly reliable measurements with reliability coefficients ranging from 0.80 to 0.85. Guided by the results of the EFA, we also conducted the CFA. The initial model fit index for organizational culture with all the 23 items showed a poor fit: CMIN/DF = 2.910; CFI = 0.888; RMSEA = 0.075. Therefore, the model was modified and four items were dropped. After removing these four items from the measurement model for organizational culture, the new model fitted the data acceptably: CMIN/DF = 2.571; CFI = 0.931; RMSEA = 0.068 (Table 1).

3.3.2.2 Open innovation In line with theoretical prediction, the outcome variable open innovation revealed two factors in EFA. However three items in total, two from in-bound open

Table 2 EFA of open innovation

Items	Factors		Item-total-correlation	Cronbach's alpha
	1	2		
IBOI.1	0.703		0.543	0.826
IBOI.2	0.762		0.621	
IBOI.5	0.858		0.746	
IBOI.6	0.828		0.705	
OBOI.1		0.810	0.667	0.822
OBOI.3		0.851	0.686	
OBOI.4		0.841	0.694	
Variance explained	31.32	22.72		
Eigen value	3.13	2.27		

innovation and one from out-bound open innovation, were dropped due to low factor loadings. Two factors obtained in EFA conducted again without the 'offending items' explained 54.04 % of the variance with Eigen value of more than 1. Consistent with the open innovation theory, these two factors were labeled in-bound open innovation and out-bound open innovation. The KMO was an acceptable 0.79 and Bartlett's Test of Sphericity was found to be significant ($\chi^2 = 1060.42$, $p < 0.001$). All the measures were highly reliable with reliability coefficients ranging from 0.82 to 0.83. In the case of open innovation, too, we conducted CFA and the initial model fit indices showed quite a reasonable fit: CMIN/DF = 1.262; CFI = 0.991; RMSEA = 0.028. However, following the results of EFA, three items from this construct were dropped as retaining these three items caused convergent and discriminant validity issues. After removing these three items, the measurement model fit was still acceptable: CMIN/DF = 1.550; CFI = 0.992; RMSEA = 0.040 (Table 2).

3.4 Convergent and discriminant validity

We assessed unidimensionality, reliability and validity of the constructs including convergent validity (correspondence or convergence between similar constructs) and discriminant validity (discrimination between dissimilar constructs) (Garver and Mentzer 1999). As is shown below in Table 3, Maximum Shared Squared Variance (MSV) and Average Shared Squared Variance (ASV) are less than Average Variance Extracted (AVE) for all the variables of this study, providing evidence in favor of discriminant validity of the variables (Hair et al. 2010). Table 3 also indicates that Composite Reliability (CR) for all the variables of this study is greater than AVE and AVE is 0.5 or greater for all the variables, indicating convergent validity of the variables (Hair et al. 2010). In addition, CR of all the variables is greater than 0.7 while factor loadings of all the items are above the cutoff point of 0.5. This provides evidence of unidimensionality of the variables and reliability of the measures used in this study (Hair et al. 2010).

3.5 Cluster analysis

Denison and Mishra (1995) state that an important approach to study organizational culture is to identify organizational culture types that involve different combinations of a set of culture dimensions. In line with this and to extract easier-to-understand conclusions about the data, we performed cluster analysis using the K-means procedure on the five dimensions

Table 3 Discriminant validity, convergent validity and reliability of measures

Construct	Dimensions	Items	Factor loading	CR	AVE	ASV	MSV	Sqr AVE
Organizational culture	Employee development	OC.EmpDev.2	0.72	0.840	0.572	0.229	0.524	0.756
		OC.EmpDev.3	0.87					
		OC.EmpDev.4	0.80					
		OC.EmpDev.5	0.61					
	Harmony	OC.Harmony.2	0.75	0.832	0.554	0.264	0.540	0.744
		OC.Harmony.3	0.78					
		OC.Harmony.4	0.70					
		OC.Harmony.5	0.74					
	Customer Orientation	OC.CustOrient.1	0.68	0.799	0.50	0.180	0.389	0.706
		OC.CustOrient.2	0.76					
		OC.CustOrient.3	0.68					
		OC.CustOrient.5	0.70					
	Social responsibility	OC.SocRes.2	0.58	0.851	0.665	0.162	0.329	0.815
		OC.SocRes.3	0.93					
		OC.SocRes.4	0.89					
	Innovation	OC.Innov.1	0.74	0.855	0.596	0.195	0.520	0.772
		OC.Innov.2	0.82					
		OC.Innov.3	0.80					
		OC.Innov.4	0.71					
Open Innovation	In-bound open innovation	IBOI.1	0.66	0.835	0.560	0.302	0.540	0.748
		IBOI.2	0.71					
		IBOI.5	0.82					
		IBOI.6	0.79					
	Out-bound open innovation	OBOI.1	0.76	0.826	0.612	0.050	0.129	0.783
		OBOI.3	0.80					
		OBOI.4	0.79					

CR composite reliability, *AVE* average variance extracted, *ASV* average shared squared variance, *MSV* maximum shared squared variance, *Sqr AVE* square root of average variance extracted

Table 4 Organizational culture dimensions under organizational culture types

	Highly integrative culture			Moderately integrative culture			Hierarchy culture			F-test
	Mean	*SD*	N	Mean	*SD*	N	Mean	*SD*	N	
Organizational culture dimensions										
Employee development	4.72	0.37	169	3.94	0.43	121	3.68	0.59	49	168.39*
Harmony	4.75	0.34	169	4.03	0.43	121	3.63	0.60	49	196.96*
Customer orientation	4.47	0.36	169	4.06	0.50	121	3.70	0.54	49	70.02*
Social responsibility	4.55	0.46	169	4.18	0.41	121	2.90	0.56	49	220.64*
Innovation	4.75	0.35	169	3.89	0.56	121	3.58	0.51	49	209.85*
Total firms	169	49.85		121	35.7		49	14.45		339

* $p < 0.01$

of organizational culture obtained in the EFA. This was done following the procedure used by Tsui et al. (2006). Results of three-cluster, four-cluster and five-cluster solutions were compared and examined. A three-cluster solution was found to be most interpretable. This three-cluster solution was also very close to the past studies including the one by Tsui et al. (2006). The first cluster had high value on all the five dimensions of organizational culture (i.e. both internal integration and external adaptation) and was named Highly Integrative Culture to describe firms' high focus on both internal integration and external adaptation. The second cluster, with a good score on all dimensions (but less than it was in case of Highly Integrative Culture) was named Moderately Integrative Culture. The third culture, with low score on all the five dimensions of organizational culture was named Hierarchy Culture. All these labels for the culture types were derived from relevant past studies. As the table below shows, the three culture types classified the surveyed firms in this study into three categories: those with highly integrative culture (169 firms; 49.85 %), moderately integrative culture (121 firms; 35.70 %) and hierarchy culture (49 firms; 14.45 %) (Table 4).

As the three clusters obtained were not continuously measured variables and thus could not be directly entered into the hierarchical multiple regression models to be employed for hypothesis testing, the three culture types were turned into dummy variables (Lee et al. 2010).

4 Findings

4.1 Hypothesis testing

We used multiple regression to test the hypotheses of this study. The results of the regression analyses are shown below.

As Table 5 above and Fig. 1 below show, organizational culture was found to predict and explain a huge variance in in-bound open innovation. The standardized regression coefficient for highly integrative culture and hierarchy culture are interpreted in relation to the reference category Moderately integrative culture. The results show that highly integrative culture positively predicts in-bound open innovation ($\beta = 0.577$; $p < 0.001$) while Hierarchy Culture relates to it negatively ($\beta = -0.163$; $p < 0.001$). Hence H1 and H3 are fully supported. On the other hand, Highly Integrative Culture is not found to have any significant

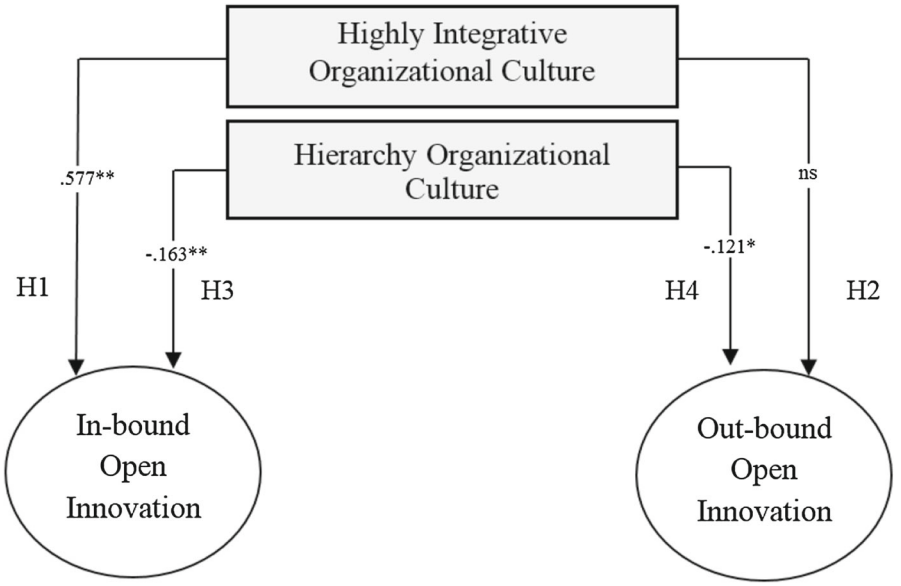
Table 5 Results of hierarchical multiple regressions

Criterion variable →	In-bound OI			Out-bound OI		
	Standardized coefficients			Standardized coefficients		
	B	Std. error	t	B	Std. error	t
Step 1: Control variable						
Industry type[a]						
Aerospace	−0.099	0.088	−1.665	−0.024	0.078	−0.574
Electronics	0.253**	0.083	4.195	0.665**	0.074	15.530
Computers	−0.115	0.087	−1.920	0.577**	0.077	13.590
Step 2: Predictor variables[b]						
Highly integrative culture	0.577**	0.053	13.242	−0.010	0.062	−0.237
Hierarchy culture	−0.163**	0.074	−3.765	−0.121*	0.088	−2.940
R^2 *change*						
Step 1	0.114			0.552		
Step 2	0.402			0.012		
F change						
Step 1	14.38**			137.42**		
Step 2	70.93**			86.31**		

* $p < 0.05$; ** $p < 0.01$

[a] Pharmaceuticals is the reference category for the dummy variables

[b] Moderately integrative culture is the reference category for the dummy variables



Note: *p<0.05; **p<0.01 ; ns = non-significant

Fig. 1 Research framework and results

relationship with out-bound open innovation ($p > 0.05$) while Hierarchy Culture relates to it negatively ($\beta = -0.121;\ p < 0.05$). Hence H2 is not supported while H4 is.

4.2 Cross validation

A regression model may demonstrate adequate prediction capability on the training data but might fail to predict future unseen data (Refaeilzadeh et al. 2009; Gigerenzer and Brighton 2009). Recent research (c.f. Woodside 2013) suggests taking a more rigorous approach in building and testing theory by ensuring predictive validity and not just relying on model fit. Hence, we use the hold-out cross validation approach to check the generalization performance of the model. In hold-out cross validation approach, the available data is split into two non-overlapped parts: one for training and the other for testing. The test data are held out and not looked at during training and the overlap between training data and test data is avoided, resulting in a more accurate estimation of the generalization performance of the algorithm (Refaeilzadeh et al. 2009). We tested for the predictive validity of the first model on the second holdout sample which showed that the model has acceptable predictive validity: r = 0.680, p < 0.000, n = 179. Similarly, we tested for the predictive validity of the second model on the first sample and found evidence for acceptable predictive validity: r = 0.726, p < 0.000, n = 160. Thus the results of this study can be considered generalizable. Detailed results of cross-validation are attached in Appendix 1.

5 Discussion

Two hypotheses of this study related to the relationships between the two types of organizational culture (highly integrative culture and hierarchy culture) and in-bound open innovation. We found that highly integrative culture enabled while hierarchy culture retarded in-bound open innovation in the surveyed organizations. These results help in understanding an important aspect of open innovation cited by Herzog (2011), West and Gallagher (2004), among others, as an important future research direction and called the "culture of open innovation". While hardly any previous study has reported such findings, the findings are not surprising.

Culture is known to support innovation by creating an organizational climate that institutionalizes innovation as an important activity. By focusing attention on innovation, a supportive culture helps to motivate and sustain the complex, interactive process of social exchange necessary for successful innovation (Russell 1989). Culture has often been cited as a major challenge when adopting open innovation (Huston and Sakkab 2006; Verbano et al. 2011) and researchers have pointed towards the significance of organizational culture in the open innovation paradigm (Golightly et al. 2012). Due to the nascence of the concept of open innovation (Maria et al. 2009), there are hardly any empirical studies that can be directly related to the findings of this study, however what this study does is to validate empirically using a decent sample what was known either conceptually or anecdotally in the open innovation literature. The findings are consistent with the work of Bell and Laurent (2012) and concur with Procter and Gamble's experience (Dodgson et al. 2006) of adopting open innovation that involved focusing on both internal integration and external adaptation and in the process experiencing a shift in its organizational culture from an inward- to an outward-looking culture.

Creating a culture that values outside competence and know-how is crucial for open innovation practice (Gassmann et al. 2010). For a firm to make this shift in its approach, organizational culture plays a critical role as it is critical for the integration of organizational processes and adaptation to the external environment (Denison and Mishra 1995). The firms

with integrative cultures have widely shared and strongly held values that address their needs of internal integration and external adaptation. By facilitating interaction of firms with their environment, Highly Integrative Culture enables in-bound open innovation in organizations with such a culture. On the contrary, firms with Hierarchy Culture lay a low level of emphasis on the values that address a firm's needs of internal integration and external adaptation (Cameron and Freeman 1991) and thus retard in-bound open innovation.

These findings are consistent with the view that traditional cultures, which are more inward-looking like the Hierarchy Culture, are often seen as a barrier to a more open approach that open innovation involves (Golightly et al. 2012). In addition, another possible reason for highly integrative culture and Hierarchy Culture to positively and negatively, respectively, impact in-bound open innovation could be that values that enhance the organization's capacity for internal integration and external adaptation can be useful for the firm in contexts undergoing restructuring and facing major changes (Tsui et al. 2006). Embarking on the open innovation journey involves problems of setting up structures for open innovation and making changes (Maria et al. 2009); and since firms may not be used to evaluating external innovation, managing such external innovations may involve many challenges (Fetterhoff and Voelkel 2006). A highly integrative culture can clearly help in tackling such challenges and enabling in-bound open innovation.

Moreover, this study revealed no significant relationship between highly integrative culture and out-bound open innovation while hierarchy culture was found to retard out-bound open innovation in the surveyed organizations. The findings are interesting and indicate that when firms have the resources and technologies and they want to sell them for lack of a fit with their existing business model, highly integrative culture does not play any role. Therefore, firms may not need to worry about having highly integrative culture to be successful in out-bound open innovation. It needs to be noted here however that there might be certain mediators in the relationship between highly integrative culture and out-bound open innovation, studying which can be a fruitful area for future research. This finding also highlights the sensitivity of handling complex cultural construct at the workplace towards which managers and practitioners should be more vigilant. Future research in this area may help managers identify the type of culture which can help enable out-bound open innovation.On the other hand, going by the findings of this study, firms need to avoid Hierarchy Culture as not doing so can retard out-bound open innovation. It seems that Hierarchy Culture retards out-bound open innovation for the same reasons it retards in-bound open innovation: that is, it places low importance on the organizational culture values that address a firm's needs of internal integration and external adaptation (Cameron and Freeman 1991).

6 Theoretical and managerial implications

6.1 Theoretical implications

The findings of this study strengthen the open innovation theory by being a valuable addition to the literature related to culture and open innovation. The paper thus helps understand how culture affects open innovation. The context of this study also makes this study important. Open innovation is practiced within the context of a given set of political and economic institutions, including regulations, intellectual property law, capital markets and industry structure (West et al. 2006). However, most of the prior research on open innovation has focused on the U.S system. It thus becomes important to examine open innovation in other contexts to clearly identify the prerequisites for and limits of open innovation. This research has made

such an attempt by helping understand the prerequisites for and limits to open innovation in the context of Malaysia. This study's findings emerging out of a developing Asian country add to the body of knowledge by providing evidence concerning open innovation in the Asian context and widen scope of the open innovation debate with new evidence from Asia.

6.2 Managerial implications

The results of this study show that highly integrative culture significantly enables in-bound open innovation. This is an important finding in that managers can veer their organizations towards Highly Integrative Culture to succeed in the open innovation paradigm. The findings bring deep insights for managers and practitioners striving to promote open innovation in the workplace. Based on the knowledge of their organizational culture, managers can even predict whether in-bound open innovation will be successful in their organizations given the present culture. Besides, this study found hierarchy culture to be related negatively to both the types of open innovation and thus managers should endeavor to avoid this organizational culture type. As cultural issues have often been identified as key barriers to implementation of open innovation in the literature (Chesbrough and Crowther 2006; Bigliardi et al. 2012), this study's findings bring clarity to the understanding of such issues. Since the main motives for firms to engage in in-bound open innovation are growth and revenue (Chesbrough and Crowther 2006), highly integrative culture can help a firm improve growth and revenue by means of enabling in-bound open innovation. This study recommends promotion of highly integrative culture in organizations so that a free flow of ideas and initiatives is possible horizontally as well as vertically. The top managers tasked with promoting open innovation in the workplace should discourage all the aspects of hierarchy culture and show strong commitment towards the promotion of highly integrative culture in their organizations.

6.3 Research limitations

Our study is constrained by a few limitations. Firstly, we surveyed only the high-tech sector in Malaysia, making the findings (probably) not completely relevant and generalizable to other sectors like the medium- and low-tech. Secondly, we used cross-sectional data which according to some researchers (e.g. Bono and McNamara 2011) may be problematic due to the mismatch of such data with the research questions that deal with causality or change. The limitations of this study point towards future research in this area. Hence, firstly, the framework developed in this study can be empirically tested in other sectors and in other country settings. Future research can look at whether the effects of the predictor variables of this study on the two dimensions of open innovation vary from sector to sector or remain the same across sectors. Similarly, the framework of this study can be tested in different country settings, particularly in developing ones like Indonesia, Thailand, India, China etcetera so that its applicability is tested across different cross-cultural contexts. Secondly, this study surveyed the manufacturing sector only, leaving ample scope for an examination of the variables of interest in the service industry. Such an examination can lead to interesting research as research into open innovation in the service industry is not only a new area of research but an under-explored one too (Chesbrough 2011). Lastly, future research can test for the mediating and moderating roles of several variables in the relationships proven and not proven in this study.

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Appendix 1

Table: Multiple regression analyses for two random sub-samples for in-bound open innovation

Split5050 = 0 **First Sub-sample (n =179)**

Model Summary[a]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.416[b]	.173	.159	.54662
2	.714[c]	.510	.496	.42334

a. Split5050 = 0

b. Predictors: (Constant), Computers, Aerospace, Electronics

c. Predictors: (Constant), Computers, Aerospace, Electronics, Hierarchy Culture, Highly Integrative

ANOVA[a,b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	10.942	3	3.647	12.198	.000[c]
	Residual	52.328	175	.299		
	Total	63.270	178			
2	Regression	32.266	5	6.453	36.009	.000[d]
	Residual	31.004	173	.179		
	Total	63.270	178			

a. Split5050 = 0

b. Dependent Variable: INBOUND.OI

c. Predictors: (Constant), Computers, Aerospace, Electronics

d. Predictors: (Constant), Computers, Aerospace, Electronics, Hierarchy Culture, Highly Integrative

Coefficients[a,b]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	4.210	.073		57.612	.000		
	Aerospace	-.026	.115	-.018	-.223	.824	.756	1.322
	Electronics	.461	.110	.334	4.181	.000	.743	1.347
	Computers	-.228	.112	-.161	-2.030	.044	.749	1.335
2	(Constant)	3.940	.070		56.581	.000		
	Aerospace	.075	.090	.051	.829	.408	.741	1.349
	Electronics	.253	.087	.183	2.889	.004	.707	1.415
	Computers	-.127	.088	-.090	-1.436	.153	.729	1.372
	Highly Integrative	.637	.071	.536	8.996	.000	.798	1.253
	Hierarchy Culture	-.299	.107	-.165	-2.807	.006	.817	1.224

a. Split5050 = 0

b. Dependent Variable: INBOUND.OI

Split5050 = 1 **Second Sub-sample (n = 160)**

Model Summary[a]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.295[b]	.087	.069	.59576
2	.737[c]	.543	.528	.42407

a. Split5050 = 1

b. Predictors: (Constant), Computers, Aerospace, Electronics

c. Predictors: (Constant), Computers, Aerospace, Electronics, Hierarchy Culture, Highly Integrative

ANOVA[a,b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	5.272	3	1.757	4.951	.003[c]
	Residual	55.368	156	.355		
	Total	60.640	159			
2	Regression	32.946	5	6.589	36.640	.000[d]
	Residual	27.694	154	.180		
	Total	60.640	159			

a. Split5050 = 1

b. Dependent Variable: INBOUND.OI

c. Predictors: (Constant), Computers, Aerospace, Electronics

d. Predictors: (Constant), Computers, Aerospace, Electronics, Hierarchy Culture, Highly Integrative

Coefficients[a,b]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	4.287	.087		49.335	.000		
	Aerospace	-.280	.133	-.188	-2.106	.037	.734	1.363
	Electronics	.230	.126	.166	1.831	.069	.714	1.400
	Computers	-.094	.133	-.063	-.710	.479	.734	1.363
2	(Constant)	3.932	.085		46.160	.000		
	Aerospace	-.115	.099	-.077	-1.155	.250	.665	1.503
	Electronics	.119	.090	.086	1.314	.191	.699	1.431
	Computers	-.017	.095	-.011	-.177	.860	.726	1.376
	Highly Integrative	.745	.080	.605	9.353	.000	.708	1.412
	Hierarchy Culture	-.268	.106	-.163	-2.524	.013	.709	1.409

a. Split5050 = 1

b. Dependent Variable: INBOUND.OI

Note: Using first sample model to predict in-bound open innovation for the second sample data: r = .680, p<.000, n = 179.
Using second sample model to predict in-bound open innovation for the first sample data: r = .726, p<.000, n = 160.

Appendix 2

Survey questionnaire

1. Organizational Culture and Open Innovation

The following statements are about the firm you work for. Please indicate how strongly you agree or disagree with these statements

	1	2	3	4	5	Strongly Disagree				Strongly Agree
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	1 ◄				► 5
1	My organization constantly scans the external environment for inputs such as technology, information, ideas, knowledge, etc.					1	2	3	4	5
2	My organization shows concern for individual development.					1	2	3	4	5
3	My organization develops employees' potentials.					1	2	3	4	5
4	My organization does not mind frequent visitors during office hours.					1	2	3	4	5
5	My organization actively seeks out external sources (e.g., research groups, universities, suppliers, customers, competitors, etc.) of knowledge and technology when developing new products.					1	2	3	4	5
6	My organization trusts employees.					1	2	3	4	5
7	My organization cares about employees' opinions.					1	2	3	4	5
8	My organization allows wearing informal dress to the office.					1	2	3	4	5
9	My organization provides training in knowledge and skills.					1	2	3	4	5
10	My organization believes it is good to use external sources (e. g., research groups, universities, suppliers, customers, competitors, etc.) to complement our own R&D.					1	2	3	4	5
11	My organization emphasizes team building.					1	2	3	4	5
12	My organization supports cooperative spirit.					1	2	3	4	5
13	My organization promotes feeling/sharing among employees.					1	2	3	4	5
14	My organization often brings in externally developed knowledge and technology to use in conjunction with our own R&D.					1	2	3	4	5
15	My organization encourages cooperation.					1	2	3	4	5
16	My organization does not mind if employees spend time with employees of rival firms over weekends.					1	2	3	4	5
17	My organization promotes consideration among employees.					1	2	3	4	5
18	My organization satisfies need of customers on largest scale.					1	2	3	4	5
19	My organization seeks out technologies and patents from other firms, research groups, or universities.					1	2	3	4	5
20	My organization strongly emphasizes profit of customer.					1	2	3	4	5
21	My organization provides first-class service.					1	2	3	4	5
22	For my organization, customer is number 1.					1	2	3	4	5
23	My organization purchases external intellectual property to use in our own R&D.					1	2	3	4	5
24	My organization provides sincere service.					1	2	3	4	5
25	My organization shows social responsibility.					1	2	3	4	5

1	2	3	4	5	Strongly Disagree	Strongly Agree
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	1 ←	→ 5

26	My organization likes to keep the air conditioner at very cold temperatures.	1	2	3	4	5
27	Generally, in my organization all technologies are externally commercialized (i.e. sold to outside firms)	1	2	3	4	5
28	My organization's mission is to serve society.	1	2	3	4	5
29	My organization emphasizes economic as well as social profits.	1	2	3	4	5
30	In my organization, external technology commercialization is restricted to technologies that are not used internally.	1	2	3	4	5
31	My organization encourages development of society.	1	2	3	4	5
32	My organization is ready to accept changes.	1	2	3	4	5
33	In my organization, external technology commercialization is restricted to relatively mature technologies.	1	2	3	4	5
34	My organization develops new products and services continuously.	1	2	3	4	5
35	My organization encourages innovation.	1	2	3	4	5
36	In my organization, external technology commercialization is restricted to non-core technologies	1	2	3	4	5
37	My organization adopts high-tech bravely.	1	2	3	4	5

2. Firm Profile

Lastly, please answer the following questions related to your firm:

Type of Industry	▪ Aerospace ▪ Computers and office machinery ▪ Electronics and communication ▪ Pharmaceuticals
Your position in the firm	▪ Middle Management ▪ Top Management (Above Sr. Manager)
How many years have you been working with this firm?	
Please indicate the age of your company	
Does your firm have an R&D department?	▪ Yes ▪ No
Firm's market	▪ Local / National ▪ Regional ▪ Global
Please indicate who owns your company	▪ Publicly owned ▪ Privately owned ▪ State owned ▪ Foreign ownership ▪ Mixed ownership/ Joint venture

Thank you for your valuable participation in this study.

If you wish to receive the summary derived from this research, please either fill in your details or attach a business card.

Name: _____ Company: _____

Address: _____

Phone: _____ E-mail: _____

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