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Critical factors for participation in global innovation networks. Empirical evidence from the Mexican nanotechnology sector

Hugo Necoechea-Mondragón [a,*], Daniel Pineda-Domínguez [b], Luz Pérez-Reveles [c], Rocío Soto-Flores [b]

[a] Instituto Politécnico Nacional, edificio de la Secretaría Académica, Av. Juan de Dios Bátiz, esq. Luis Enrique Erro Col. Residencial Escalera, C.P. 07738 Ciudad de México, Mexico
[b] Departamento de Administración, Escuela Superior de Comercio y Administración, Santo Tomás, Instituto Politécnico Nacional, Carpio 471, Col. Plutarco Elías Calles, CP 11340 Ciudad de México, Mexico
[c] Subdirección de Transferencia Tecnológica, Centro de Nanociencias y Micronanotecnologías, Instituto Politécnico Nacional, Luis Enrique Erro s/n, Nueva Industrial Vallejo, 07738 Ciudad de México. Mexico

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ABSTRACT

To face the new challenges of globalization, research institutions and companies are adopting new approaches in innovation processes. Corporations no longer rely on a single, linear innovation structure. In recent years, in several countries, institutions and companies have implemented innovation through global innovation networks (GINs) to launch new products in the market ahead of competitors. Nevertheless, there is scant literature examining the main factors involved in GIN participation practices. To address this gap, this paper used the case of nanoscience research centers in Mexico. The aim of this research was to assess the degree to which critical innovation factors enable Mexican research centers and institutes of nanotechnology to participate in GINs. First, data were gathered from questionnaires sent by e-mail to researchers in research institutions; then, correlation and regression analysis were used to find the relations among variables. The results showed that critical factors such as human resource competencies in innovation, open innovation and technology transfer skills have a direct influence on the participation of Mexican research centers and institutions in GINs.

1. Introduction

Changes in international markets have created many challenges and substantial uncertainty around companies' globalization processes (Fang and Zigang, 2004; See et al., 2015; Walsh et al., 1999). International activities are increasing and the modes for conducting globalized activities are becoming progressively more diverse (Audretsch et al., 2014; McCarthy et al., 2012). The global restructuring process is accompanied by a scarcity of resources and knowledge, which forces firms and governments to consider opportunities for sustainable growth (Anson et al., 2008; Bleischwitz, 2010; Falize and Coeurderoy, 2012; Fink et al., 2013; Kautt et al., 2007; Smitha et al., 2010).

Globalization increasingly affects how companies in OECD countries operate, compete and innovate, both in their home country and worldwide (Dieter. Ernst, 2002; OECD, 2008b). Companies now face an environment in which competition is global, knowledge is widely disseminated, investments in research and development (R&D) are increasing, and product life cycles are shrinking (Allarakhia and Walsh, 2011; Allarakhia and Walsh, 2012; Kuznetsov and Dahlman, 2008; Tierney et al., 2013). To cope with these new challenges, companies must adopt new approaches in a number of areas, including innovation processes, organizational models, financial models and decision making (Groen et al., 2002; OECD, 2008a; Prahalad and Ramaswamy, 2004; Rhéaume and Gardoni, 2015; Walsh and Linton, 2001).

In the globalization context, it is clear that the traditional process of innovation, in which a company maintains and funds a centralized system of R&D, is being gradually transformed (Allarakhia and Walsh, 2012; Carrillo and Lara, 2005; Jenn-Hwan, 2007; Walsh and Linton, 2002). Specifically, companies in a variety of industries are looking for ways to disaggregate their R&D and distribute their innovation processes through an external network of partners and sites across the world (Tidd and Bessant, 2013). This system allows multinational enterprises (MNEs) to allocate activities according to the strengths of certain countries and external research centers and thereby make their R&D processes more efficient, keeping these MNEs at the forefront and enabling them to launch new products or services in markets ahead of competitors (Buckley, 2014; Tierney et al., 2013).

One form of organization that companies have adopted to implement open innovation is the creation of GINs (Chaminade and Barnard, 2009; OECD, 2008b; Papadopoulos et al., 2013).

Despite the increasing recognition of the importance of GINs and the key role played by research centers-universities within networks, empirical evidence remains elusive (Pereira et al., 2011). Although research

* Corresponding author.
E-mail addresses: hnecoecheam@ipn.mx (H. Necoechea-Mondragón), danpin07@yahoo.com.mx (D. Pineda-Domínguez), luxperez@hotmail.com (L. Pérez-Reveles), mrsoto03@yahoo.com.mx (R. Soto-Flores).

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centers-universities are typically seen as important for the emergence of GINs, there are few studies that focus directly on their role (Albuquerque et al., 2011). The literature on GINs identifies the available talent pool in peripheral countries as one key driver of GINs (Dieter. Ernst, 2006). Certain firms identify research centers-universities as their most important collaborative partners, ahead of customers, suppliers, alliance partners and even joint venture partners (The_Economist_Intelligence_Unit, 2007).

Universities and research institutes are identified as critical sources of innovation; thus, there is a growing trend towards the globalization of industry-science relationships. Examples of Asian firms that have established GINs with universities in the USA and Europe include China's Huawei (Ernst and Naughton, 2008) and Taiwan's TSCM (Dieter. Ernst, 2009a).

A small number of regions in the developing world have already managed to exploit opportunities provided by the new global landscape to accumulate technological capabilities and have occasionally even become specialized hubs in global knowledge networks (C. Chaminade and Vang, 2008).

Technological advancement has been one of the main factors in the improvement of living conditions in society (Reichardt et al., 2016). Although economic growth depends on multiple factors, science and technology (S & T) have been considered catalysts for socio-economic progress (Hekkert et al., 2007; OECD, 2008a). Among the major limitations of the Mexican scientific system is that the work developed in its research institutes has been organized primarily based on the incomplete views of the government and certain researchers regarding the needs of S & T activity (E. Robles-Belmont, 2010). The design of financial and logistical programs for research support rarely results from a study of the country's industrial needs that considers the interests of both academia and business (Záyago-Lau and Foladori, 2010). These programs have also been designed without consideration of the rapid changes in how businesses are organized worldwide to generate innovation.

In Mexico, nanotechnology has been recognized as a strategic growth area (DOF, 2008). This technology, along with other emerging technologies, is essential to "improve the standard of living of society and become more competitive" (Allarakhia and Walsh, 2012; Eduardo. Robles-Belmont et al., 2008). However, to date, there is no national plan or national initiative in nanotechnology. There is no office or administrative council to establish the goals and direction that nanotechnology should adopt in Mexico (Záyago-Lau and Foladori, 2010). In 2012, Faladori et al. analyzed the extant scientific bilateral agreements in nanotechnology between Mexico and the United States and concluded that there are few opportunities for bilateral collaboration between the countries in the broad nanotechnology area (Foladori et al., 2012).

Building on this, our study aims to assess the degree to which critical innovation factors enable Mexican research centers and institutes of nanotechnology to participate in GINs. This study seeks to answer the following question: Do innovation factors determine the participation of Mexican research institutes in global innovation networks in the nanotechnology sector? Through a survey of 59 researchers at nanotechnology research institutions in Mexico, we examine the effect of critical innovation factors on their participation in GINs.

In the next section, we discuss the relevant concepts used in this paper and derive the hypotheses to be tested. Section 3 discusses the methodology for this study. We present the results in Section 4. Section 5 concludes the paper.

2. Literature review

2.1. Critical innovation factors for networks

An important characteristic of innovation in emerging technological fields is that it does not occur in isolation (Kassicieh et al., 2002; Markard and Truffer, 2008). On the contrary, innovations are generated and implemented by networks of interacting organizations and individuals (Subramaniam and Youndt, 2005; Thukral et al., 2008). As a result, organizations are increasingly establishing access to complementary knowledge networks (Barnard and Chaminade, 2011). Disentangling these various factors and understanding the nature of innovation in networks present a theoretical challenge that must be addressed in this context.

According to the Organization for Economic Cooperation and Development (OECD), the first factor that has contributed significantly to innovation in networks is globalization (Marquis, 1969; OECD, 2008b; Walsh and Linton, 2011). In an environment of globalization, enterprises must be open to ideas from R&D, to complement both internal and external ideas and to remain competitive (Chesbrough, 2006; Tassey, 2008). Due to increasingly intense technological progress and global competition, product life cycles have been drastically reduced, forcing companies to innovate faster and develop products and services more efficiently (Ahuja, 2011; Dieter. Ernst and Linsu, 2002; Von Zedtwitza and Gassmannb, 2002).

A second innovation factor is the practice of open innovation. Changes in the relationships between companies and other sources of innovation have led companies to implement "open innovation" (Chesbrough, 2004; Chesbrough, 2006; Chiaroni et al., 2011; Huizingh, 2011; OECD, 2008a). Open innovation not only aims to acquire external knowledge ("outside-in") but also endeavors to find ways to generate additional revenue from internal innovations ("inside-out") (Chesbrough, 2006; Garcia-Martinez, 2013; Huizingh, 2011; Necoechea-Mondragón et al., 2013).

A third factor involved in network innovation is the availability of educated, competitive human resources who are competent in innovation (Albuquerque et al., 2011; McAdam et al., 2004). Engineering and scientific resources available in countries such as China, Brazil and India have opened new opportunities for multinational companies to hire specialized workers for lower wages (Dieter. Ernst, 2006; Freeman, 2005). Global firms must improve their access to a limited global pool of knowledge workers (Ruia and Yipb, 2008). The shift to knowledge-intensive industries has increased the importance and scarcity of well-trained knowledge workers (Dieter. Ernst, 2005). Thus, for many high-tech companies, competing for scarce global talent has become a major strategic concern (Palacios, 2008; Tassey, 2008; Vitae, 2010). This factor is closely related to the interaction among universities, public research institutes and multi-national corporations (MNCs) in the education and training of a pool of highly skilled knowledge workers, scientists and engineers (Lorentzen and Gastrow, 2012). The literature on GINs assumes a largely implicit relationship between GINs and universities and research institutes (Chaves et al., 2013; Pereira et al., 2011). A central study conducted by The Economist Intelligence Unit (2007) found that the majority of surveyed firms identified universities and educational establishments as their most important collaborative partners, ahead of customers, suppliers, alliance partners and even joint venture partners (The_Economist_Intelligence_Unit, 2007).

A fourth factor that is intertwined with the emergence of innovation networks is the transformation of the international division of labor (Bucklye and Ghauri, 2004; Zuniga and Crespi, 2013). There is an increasing division of labor, or vertical specialization, in innovation (Dieter. Ernst, 2009b). Global firms have been able to increase vertical specialization in innovation, which has given rise to global markets for technology (Dieter. Ernst and Kim, 2002; Kruss and Gastrow, 2012).

A fifth factor is that a firm's competitive success is now critically dependent on its ability to transfer technology and to monitor and quickly seize upon external sources of knowledge, which are now key elements of competition (Chun-Chu, 2007; Necoechea-Mondragón et al., 2013). Global firms must supplement their in-house creation of new knowledge and capabilities with basic or generic technologies developed elsewhere, perhaps even using reverse innovation (Chung, 2001; Govindarajan and Ramamur, 2011; Von Zedtwitz et al., 2015).