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DEVELOPMENT OF LOCAL INNOVATION CAPABILITIES FOR GLOBAL R&D PROJECTS INTEGRATION ON MNES

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Abstract

This article extends knowledge concerning the building of local innovation capabilities that contribute to enables multinational subsidiaries from emerging markets its insertion in global R&D global projects opening opportunities for the attraction of R&D centers. The results outline the importance of these local capabilities and contributes to demonstrate that, in emerging markets, the insertion of multinational subsidiaries in global R&D projects occur through an evolutionary process that starts with local capabilities development in process/product innovation, for then evolute to develop of R&D local capabilities through the local collaboration with partners and institutions. Our research investigated 131 foreign multinational subsidiaries operating in Brazil, in which were interviewed from two to five directors or executives at C-Level and from Innovation, R&D, Engineering, Product Development, Projects departments. Our results show that the participation and the innovation in process and product are a result of the specific characteristics of the market but also the targeting of R&D local activities for capability build that lead to the insertion in global project, especially for companies on emerging markets contexts. Moreover, some theoretical and managerial contributions are presented as well as some directions for future research.

Keywords: Local innovation capabilities; Innovation in emerging markets; Global R&D projects; Collaborative R&D

Resumo

Este artigo amplia o conhecimento sobre a construção de capacidades locais de inovação que contribuem para possibilitar às subsidiárias multinacionais de mercados emergentes sua inserção em projetos globais de P&D globais abrindo oportunidades para a atração de centros de P&D. Os resultados descrevem a importância dessas capacidades locais e contribuem para demonstrar que, em mercados emergentes, a inserção de subsidiárias multinacionais em projetos globais de P&D ocorre através de um processo evolutivo que começa com desenvolvimento de capacidades locais em inovação de processo / produto, para então evoluir para desenvolver de capacidades locais de P&D através da colaboração local com parceiros e instituições. Nossa pesquisa investigou 131 multinacionais estrangeiras que operam no Brasil, nas quais foram entrevistadas de dois a cinco diretores ou executivos de nível C e de departamentos de Inovação, P&D, Engenharia, Desenvolvimento de Produtos e Projetos. Nossos resultados mostram que a participação e a inovação em processo e produto são resultado das características específicas do mercado, mas também do direcionamento de atividades locais de P&D para capacitação que levam à inserção em projetos globais, especialmente para empresas em contextos de mercados emergentes. . Além disso, algumas contribuições teóricas e gerenciais são apresentadas, bem como algumas orientações para futuras pesquisas.

Palavras-chaves: Capacidades de inovação local; Inovação em mercados emergentes; Projetos globais de P&D; P&D colaborativo

1. INTRODUCTION

In the face of decentralization of the organizational innovation process activities (Papanastassiou and Pearce, 2005), both for developed countries (Håkanson and Nobel, 1993) and developing countries (Zeschky et al., 2011), the activities of the subsidiaries, initially focused on simple adaptations aimed at the local market, began to share their competition strategies in building innovation capabilities to the world market (Cantwell and Zhang, 2009). This shift of knowledge flow fostered by gradual technological effort in the formation of local capabilities (Marin and Sasidharan, 2010) has opened new opportunities to subsidiaries for participation in global innovation projects (Ernst, 2009).

The subsidiaries of emerging countries have not been left out. With the growing decentralization of R&D activities and specific local capacities developed in these markets (Figueiredo, 2014), subsidiaries now represent an important role in multinational companies (Govindarajan and Ramamurti, 2011; Marin and Bell, 2010; Marin and Giuliani, 2011). Studies conducted in the 1990s showed the focus of Brazilian subsidiaries in operational activities, without global vision (Costa and Queiroz, 2002). However, the latest research demonstrates positive results on the intensity of local innovation activities of subsidiaries and their involvement in global strategy (Marin and Costa, 2013) in specific industries (Ariffin and Figueiredo, 2004; Athreye et al., 2014).

In order to study the relationship between the development of local innovation capabilities in collaboration in R&D and integration in global projects, the following question was proposed: Does the development of local innovation capabilities contribute to multinational subsidiaries in emerging economies being able to integrate into global R&D projects?

The objective of the study is to discuss the role of local bulding of product, process, and R&D innovation capabilities to enable the insertion of multinational subsidiaries in global R&D projects.

We argue that the more subsidiaries are internally and externally rooted in networks of R&D learning dynamics in collaborative participation with universities, R&D centers, and other companies, the more advanced their local innovation capabilities are, which allow greater inclusion and success in global innovation projects (Gemuenden and Lechler, 1997).

Our article contributes to the literature in emerging markets that indicates its potential in the field of innovation (Govindarajan and Ramamurti, 2011) and the development of local innovation capabilities in the subsidiaries is an agent for the insertion of subsidiaries in multinational global projects (Bell and Figueiredo, 2012; Iammarino et al., 2008; Lema et al., 2015).

Our results show that the participation and innovation in process and product are a result of the specific characteristics of the market but also the targeting of R&D local activities for capacity building that lead to the insertion in global projects.

The evidences of this research contribute to the evolutionary and learning approach (Bell and Figueiredo, 2012; Nelson and Winter, 1982) when it is important to create institutional mechanisms to promote cooperation and learning among foreign subsidiaries in emerging countries and research institutions and development, and consequent training of enterprise resource capabilities to participate in global innovation projects. In other words, the local innovations of the subsidiaries are essential for integration into global innovation projects due to the integration of the low and intermediate complexity of the technology used in the production of goods and the advanced capacities resulting from the intensity of internal and external collaborative participation in R&D (Gemuenden and Lechler, 1997; Iammarino et al., 2008).

The nature of innovation capabilities in emerging markets reflects not only the primacy of R&D and patent activities, but also a path of dependence on the evolutionary routines and learning of product and process allied to different innovative activities and technological functions originating in the interaction between dispersed R&D centers and local institutional ecosystem (Qiu and Cantwell, 2018).

Notwithstanding, if the subsidiaries wish the integrate of them local capabilities in global projects, it is up to them to implement specific strategies targeting the R&D centers to explore and integrate advanced skills, with innovation reverse practices, creation new products and processes for international markets, access and attraction opportunities to new investments in R&D resources and breakout knowledge in global innovation.

The article also contributes to executive decision making about the importance of developing local innovation capabilities in Brazilian subsidiaries and participation in global projects and consequent competitiveness of the subsidiaries (Borini et al., 2014; Santos et al., 2004).

2. LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

2.1 Integration of subsidiaries in emerging markets in global projects of R&D

Global innovation projects express the overall trend of multinationals from developed countries, who capture new knowledge from sources outside of their country of origin and also from emerging countries (Govindarajan & Ramamurti, 2011), to take advantage of their positions to access multiple competitive contexts (Meyer, Mudambi, & Narula, 2011).

The significant increase of global innovation projects, integrated across time zones, with informational and collaborative platforms (Chiesa, 2000), was driven by macro and micro-institutional factors. In macro terms, the global projects are a result of several factors that include the speed of technological change, reliance on expertise in restricted regions (von Zedtwitz, Gassmann, & Boutellier, 2004) and low operation cost generated by the internationalization of markets (Meyer et al., 2011; Narula, 2014).

In terms of micro-institutions, the development of global R&D projects are associated with the use of existing local capacities in the subsidiary (S.-H. Chen, 2004; Iammarino et al., 2008); evolution of global production networks for global innovation networks (Cooke, 2013; Ernst, 2009), global mandates and autonomy of subsidiaries (Ghoshal & Bartlett, 1988; Zeschky, Widenmayer, & Gassmann, 2014), the recognition of the existence of centers of excellence (Chiesa, 2000), the existence of networks of relationships between suppliers and subsidiaries (Bäck & Kohtamäki, 2015; Meyer et al., 2011) and the development of efficient communication systems for mobility innovation (Ernst, 2009).

As pointed out by these surveys, for participation in global innovation projects, the development of local capacities by emerging markets are related to strategies aimed at the evolution of existing R&D centers and attraction for the installation of new centers of excellence.

Demirbag and Glaister (2010) conclude the migration of these centers to emerging markets, such as India and China, is due to low operating costs, including wages, plus an institutional environment conducive to the development of innovation, such as: knowledge infrastructure and intellectual capital in science and engineering, and mitigation of political risks through participation in global R&D projects, as well as experience in projects and cumulative learning.

As for the evolution of the subsidiary's mandate status to the global excellence status with new attributions, this will depend on the matrix's perception of the existence of unique and unique competencies in relation to the other actors that make up the organization's global innovation network (Cantwell & Mudambi, 2005; von Tunzelmann & Wang, 2007).

Among emerging countries, China and India have been prominent both in attracting R&D centers in relation to knowledge infrastructure and low wages in relation to developed countries

(Demirbag & Glaister, 2010), in the levels of expertise in specialized sectors, and in the participation in the patent portfolio (Gerybadze & Merk, 2014). This growth in participation in the patent portfolio explains China's transition to a superpower of innovation (Granstrand & Holgersson, 2014) and as a global integration center for R&D activities (Qi, Wang, Zhang, & Zhu, 2014).

For India, academic networking relationships and expertise in the technology of software segments and information technology services support local strategies for attracting R&D centers (Gerybadze & Merk, 2014).

In summary, the development of global projects is a direct reflection of R&D investments carried out by multinationals (Gerybadze, 2004) and of the exploitation of the local capacities of subsidiaries for product planning, access to markets and information and communication networks (S.-H. Chen, 2004).

Active participation of the subsidiaries in the operating flow of knowledge exploitation (Marin & Sasidharan, 2010) promotes development of R&D centers distributed in each country (S.-H. Chen, 2004; Chiesa, 2000; Gassmann & von Zedtwitz, 1999) since global innovation processes are often fragmented into multiple nationalities characterized by global networks of innovation (Cooke, 2013; Ernst, 2009; Parrilli, Nadvi, & Yeung, 2013).

Although common architectures of operation and shared integration between global production networks and the global innovation networks can be identified (J. Liu, Chaminade, & Asheim, 2013) and the last to be recognized as the first extension, they differ in their aims and results (Ernst, 2009; Parrilli et al., 2013). Despite the role of global network of production on the dispersal of innovation capabilities and the outsourcing of knowledge activities (Ernst, 2002), for some authors (Cooke, 2013; Ernst, 2002; Parrilli et al., 2013) these networks are limited to the vision of the relationship between the productive areas of geographically distant areas, and are static regarding innovation required in global markets.

On the other hand, the global innovation networks are more prepared for the uncertainties of the global market in constant change (Cooke, 2013), since its formation is due to the flow of knowledge between regions, companies and external agents such as suppliers and research institutes (Cooke, 2013; Ernst, 2009).

While the growth of global networks of production is dependent on the production arrangements between the subsidiaries and array (Ernst, 2002), the growth of global networks of innovation is supported in learning processes, patterns of interaction between the different actors of the network, and their multilateral contributions with institutional innovation systems in which they are inserted (Lundvall, 1992). This integration based on innovation promotes the opportunity for leadership development and competitiveness to the multinational (Ernst, 2009).

Studies shown that the evolution of R&D activities to adapt products and processes in foreign subsidiaries in China to integrated global R&D center has been achieved by developing project management skills and competencies, process improvements and quality assurance, as well as product development skills from local embedded R&D units or global system (Qi et al., 2014; von Zedtwitz et al., 2004).

In Brazil, recent studies on the automotive industry, demonstrate the change of activities of foreign subsidiaries from execution of adaptations of products to the local demand for the design of a unique vehicle project, and subsequent leadership of the project, working in global teams (Ernst, 2009; Ibusuki, Bernardes, & Consoni, 2015; Lema et al., 2015). Furthermore, advances in innovation and global participation in projects prove that the more integrated foreign subsidiaries installed in Brazil are in global innovation networks, the greater the value that they add locally and greater is their global recognition (Marin & Costa, 2013).

The authors Malerba (2003) and Cassiolato, Lastres, and Maciel (2003) discuss how regional innovation systems positively influence local innovative performance, demonstrating evidence of the role of the density of institutional interaction among actors for the dynamic development of innovation capabilities. Reinforcing this approach, Gassmann and von Zedtwitz (1999) emphasize the importance of the R&D centers of these subsidiaries to be rooted in regional institutional collaborative environments for insertion in global innovation projects.

In this context, in R&D centers integrated into a network of knowledge involving local institutions of research and development in learning (Lema et al., 2015) can ensure an insertion in global projects. In this sense, it is important to understand the attributes of locally developed capabilities that lead to insertion in global networks. The benefits generated for the country are of interest to both the subsidiary and the multi-national.

For emerging countries, the benefit of the subsidiaries installed in global innovation networks relates to learning in technological training (Figueiredo, 2014), creating opportunity for amendment of activities related to production capacity that broaden the competitive advantage through innovation (Ernst, 2009). On the other hand, for the multinational in search of its competitiveness by means of global projects (J. Liu et al., 2013), the challenge is to integrate local innovations of these subsidiaries in the developed market (Govindarajan & Ramamurti, 2011). This means that the evolution of global innovation networks is not necessarily a consequence of the complementarities of the local skills and knowledge transfer between local and international agents, but, above all, the development of innovation capabilities (Bell & Albu, 1999) with global potential (Govindarajan, 2012). The subsidiaries must develop their local capabilities with global potential to move the focus on the product from imitation to focus on innovation (Li & Kozhikode, 2009).

From the market perspective, the result of this global integration of innovation is the emergence of initiatives that meet the needs of existing and potential customers (Herrmann, Gassmann, & Eisert, 2007) in response to the increasingly complex needs of these markets and products (von Tunzelmann & Wang, 2007).

2.2 Development of local R&D centers and insertion into global projects

While previous studies for developed markets already reflect a positive impact of R&D activities for innovation, studies for the emerging market show that the growth of these markets, along with the cost and quality of resources has also attracted R&D centers (von Zedtwitz, Corsi, Søberg, & Frega, 2015). Traditionally, the dispersed centers of R&D in developing countries fit mainly in R&D categories centered in subcontracting costs for low-value activities (Gassmann & Han, 2004). However, the last decade has seen the emergence of centers with activities directed to research in production and manufacturing (Amsden & Tschang, 2003), R&D geared to new technologies for production to meet the local market (Y.-C. Chen, 2008) and although few, but existing advanced R&D centers in specific sectors are specialized for the market and global technology (Y.-C. Chen, 2008).

Thus, from initial support to global projects, R&D centers began to expand their activities with a focus on innovation to meet the local market toward participation in local and global projects within the global matrix network (Birkinshaw, 2001). This evolution has allowed the consolidation of the complexity of corporate and technological expertise in the scattered R&D centers of excellence (Narula, 2014; Patel & Pavitt, 1998).

In other words, even if the matrix is the main source of knowledge for the subsidiaries (S.-H. Chen, 2004), local R&D in subsidiaries to obtain technology is also important (S.-H. Chen, 2004). The knowledge generated by these local R&D centers are availed both regionally to local adaptations, as in accumulation of new skills and solutions that can be utilized globally (Asakawa & Lehrer, 2003).

In this sense, emerging markets have become poles of attraction for large multinationals wishing to install in its subsidiaries and R&D units a new approach to overall contribution to the headquarters and local responsiveness (Brem & Wolfram, 2014; Soni & Rishikesha, 2014). The R&D laboratories in emerging markets have contributed to global knowledge and enhanced the technological capabilities and local expertise (Yang & Hayakawa, 2015), as well as through its strategic importance in the overall structure, bringing the seal of recognition for local capacity in subsidiaries (Bell & Figueiredo, 2012).

Recent innovation research in emerging countries show that the efforts of countries like China and India to build local capacity attracted multinationals to set up their R&D centers (Altenburg, Schmitz, & Stamm, 2008), starting with product adaptation activities to the local market and advancing to more complex activities of research and development (UNCTAD, 2005). In India, the R&D activities initially focused on the local market, and then expanded the portfolio of globally available innovations with high-tech and low cost products with differentiated features of products from developed countries, and integrated a complementary development between the subsidiaries and the array (Ojha, 2014).

In the context of integrating into global innovation projects from R&D capabilities, previous studies show that the most innovative subsidiaries are those with the highest local routing in R&D networks to universities, research institutes, and other companies, using external learning mechanisms for knowledge creation (Marin & Bell, 2010).

These studies support the importance of the influence of existing knowledge on these local actors in the country where the subsidy is installed (Cantwell & Mudambi, 2005; Iammarino et al., 2008), and are fundamental for understanding the participation of emerging markets in global R&D innovation networks.

Given the growing importance of setting up local research centers in emerging markets and the collaboration between a subsidiary and other R&D centers for local capacity development and integration into global projects, the following hypothesis is proposed:

> **Hypothesis 1**: *The insertion of foreign subsidiaries operating in Brazil in global projects is associated with the accumulation of local R&D capabilities.*

2.3 Local capability building of product innovation

The participation of emerging countries in global networks of product innovation has evolved in the last decade (Marin & Bell, 2010; Marin & Costa, 2013). The innovation and development of new products are related to the use of existing resources (de Brentani & Kleinschmidt, 2015; Ghoshal & Bartlett, 1988; Wan, Ong, & Lee, 2005) and the ability to use local knowledge to create, adapt or reproduce products (Phene & Almeida, 2008). New products developed in emerging markets in many cases are very competitive, achieve better performance and are more innovative than those in developed markets are. As result, these products could be transferred to developed markets through reverse innovation and become global products (von Zedtwitz et al., 2015).

Therefore, for a multinational, competitiveness may lie also in the innovations of products and solutions that originate in developing countries (Agarwal & Brem, 2012). Multinationals have directed the development opportunities of its product portfolio in these regions for low-income consumers (Agarwal & Brem, 2012).

Subsidiaries have expanded their capacity for innovation with the main objective to first meet resource constraint needs with products that keep their main functions, have a low cost of production and present new features to the market (Brem & Wolfram, 2014). Even if multinationals do not have as a main objective the transfer to developing countries, they have the potential to create a reversal of the insertion flow of products from developing countries to the developed countries (Agarwal & Brem, 2012). In this way, expanding the global innovation

model (von Zedtwitz et al., 2015) and opening new market demands that look for low-cost innovations (Govindarajan & Ramamurti, 2011).

This new flow of innovation is a result of the evolution of the activities of the R&D centers in the subsidies installed in emerging countries. Although these activities are fragile in these markets (Altenburg et al., 2008; Cheng & Shiu, 2012), they bring benefits to the absorption of advanced technologies and the use of the knowledge obtained from the organization for local capacity building and product innovation (Altenburg et al., 2008; X. H. Liu, Lu, Filatotchev, Buck, & Wright, 2010).

As a result of the organization of its activities in production capacity, the subsidiaries use the local basic and applied research centers as a technological resource for innovation in products in the subsidiaries (Iammarino et al., 2008). In this way, while local capacities are measured by the introduction of new products and services, skills developed jointly with local and external R&D centers are the means to produce these goods and services (Iammarino et al., 2008).

Thus, the development of product innovation capabilities practiced by subsidiaries and centered on emerging markets may have the potential to be exploited by the multinational in other emerging and developed countries. Subsidiaries holding this innovativeness in product would be able to enter into R&D global innovation networks not only with a peripheral role, but also with the potential to coordinate the development of products to developed markets and others emerging markets.

Considering the literature of global product development and the studies of the insertion of subsidiaries in emerging markets, the following hypothesis is proposed:

> **Hypothesis 2a**: *The insertion of foreign subsidiaries operating in Brazil in global projects is associated with the accumulation of local innovation capabilities in products.*
>
> **Hypothesis 2b**: *The insertion of foreign subsidiaries operating in Brazil in global projects is associated with the accumulation of local capabilities of product mediated positively by local R&D capabilities.*

2.4 Building local capabilities in innovation processes

The capabilities involved in process innovations are related to the knowledge that makes them more efficient from the point of view of improvement or novelty (exploitation), and their exploitation can contribute to the results in innovation of organizations (exploration) as global solutions (Ariffin & Figueiredo, 2004; Cantwell & Mudambi, 2011).

For the emerging market, the innovative efforts of companies follow a reverse trajectory towards the central economies where there is a predominance of the dissemination of innovation in the search for technological leadership. For emerging countries, learning cycles from recombination of existing technologies to meet local needs for new processes and new business models earn more importance (Govindarajan & Ramamurti, 2011).

For Altenburg et al. (2008), the transition from production capabilities to innovation capabilities in China and India refers to the creation of new knowledge, obtained through investments in local capabilities in reverse- engineering, and new learning paths for internal and external acquisition of skills related to the production processes, placed in use locally. The importance of this transition, for insertion in global projects, is that local innovation enables the subsidiary to participate in global markets (Jha & Krishnan, 2013), with high-quality solutions and sophisticated production processes (Altenburg et al., 2008).

If considered the example of developed markets, when there is an interaction between the R&D centers and the development of local capacities of product and process, an opportunity exists for local innovation to gain global scope.

In spite of being a different technological scenario for the subsidiaries in emerging countries (Figueiredo, Andrade, & Brito, 2010), the insertion in global projects of emerging countries is more a result of the evolution of the accumulation of production capacities and participation in global projects, building a trajectory of evolution of knowledge (Figueiredo, 2014, 2016).

In other words, the development of local capacity for process innovation and integration into global projects is the result of a cost reduction path in incremental innovations and participation in global projects (Demirbag & Glaister, 2010).

In this way, we hope that the local R&D activities, developed in the Brazilian subsidiary, have interacted in the relation of the local capacities of process innovation and the insertion in global projects.

Some studies suggest that global participation for emerging is due to reversal of the activities of basic research flow to focus product and process development (von Tunzelmann & Wang, 2007). Others point out that the growth of demand, the size of local markets, as well as the trained human capital, has encouraged emerging countries to transition from mature technology and imitation activities toward innovation for process and product (Agarwal & Brem, 2012).

In summary, the process of innovation of subsidiaries of emerging countries when aimed at cost reduction routines and functionalities, driven by local needs, can provide differentiated technological capabilities of interest to the multinational because they allow market gains and improved global margin. The market gain comes from the reapplication of process innovations in other emerging markets and the increase in the margin through the introduction of lower-cost and optimization routines for operations in the developed markets.

Thus, it is proposed that:

> **Hypothesis 3a**: *The insertion of foreign subsidiaries in Brazil in global projects are associated with the build-up of local capabilities in processes innovation.*
>
> **Hypothesis 3b**: *The insertion of foreign subsidiaries operating in Brazil in global projects is associated with the accumulation of local capabilities of process mediated positively by local R&D capabilities*.

3. RESEARCH METHODS

To answer the research question by means of the formulated assumptions, the association of local capabilities of processes and products in global projects and the existence of moderating local innovation capacity in R&D on these associations, a survey was applied to collect primary data. This study used structural equation modeling (SEM) as a statistical technique to analyze the data, according to the impact relationship investigation model generated by the independent variables on the dependent variable, in the analysis of relations of independent variables on the dependent variable (Hair, 2010). Thus, the analysis of probabilistic model of more than one independent variable of the constructs local capacity for innovation processes (LPSI), local capacity of product innovation (LPDI), local capacity of innovation in R&D (LRDI), insertion of the dependent variable in global projects (IGP) were represented by observable variables obtained from the questionnaire and analyzed by SmartPLS 3 software.

3.1 Sampling and data collection

The unit of analysis of this research are the subsidiaries of foreign multinationals in Brazil and the relationship of access to global innovation networks from local capabilities. The approach includes industrial companies and companies in the service sector, excluding companies in the low-tech service sector.

The sample of surveyed companies were assembled from crossing the base without data duplication, from the Business Monitor Company, and base of companies identified in the magazine survey Biggest and Best 2013 (Exame, 2013), reaching the total of 693 companies, and 611 valid contacts for directing the research. The electronic questionnaire was sent by email

to 611 contacts, with accompanying answers and telephone contact for clarification. After debugging data related to errors of filling, duplication, and lack of information, the sample was reduced to 131 participating companies. Thus, the final sample comprises 131 companies, from services and industrial sectors, with a response rate of 21.4 % of the initial sample.

The sample is characterized by a sampling of foreign subsidiaries operating in Brazil. Hair (2010) considers five respondents by questionnaire item sufficient to sample composition. Considering the 16 questions of the survey instrument that will be used for this study and the premise of Hair (2010), the minimum amount is 80 respondents. Therefore, the sample of 131 respondent companies is above the minimum recommended size for this study. This sample is composed of 86% of companies in the industrial sector and 14% in the service sector. The sample of foreign subsidiaries in Brazil has the following distribution of country origin: United States (39%), Germany (18%), Japan (9%), France (8%), Italy (4%) and England (4%), constituting 80% of the sample.

Based on the assumptions presented, the dependent variables, independent variables, and moderators of this study are presented below.

3.2 Measurement of Constructs

The dependent construct insertion in global projects of R&D (IGP) (von Zedtwitz et al., 2004) aims to demonstrate the intensity in which the multinational subsidiary installed in Brazil participates in simultaneous global projects involving global innovation teams. This construct is formed by the following issues: (IGP_1) our subsidiary often carries out projects involving the management of concurrent global projects in R&D; (IGP_2) the last three years its subsidiary often created new products and processes for the global market; (IGP_3) the last three years its subsidiary often conducted development activities of new products or components for the global market; (IGP_4) the last three years its subsidiary developed and continuously transferred R&D techniques (research and development) for the matrix and/or other subsidiaries (Cronbach Alpha of 0.843).

The independent construct Local Process Innovation (LPSI) was developed in Iammarino et al. (2008), who took as a theoretical basis the studies of Bell and Pavitt (1995), Ariffin and Figueiredo (2004). This scale was segmented into levels of complexity of the technological capabilities of processes and products. Considering this segmentation, the construct was built through the following questions: (LPSI_1) our subsidiary often performs small changes in process technology to adapt to local conditions; (LPSI_2) our subsidiary often makes significant improvements in the production process (layout enhancement, material flow and process automation lines, and/or elimination of bottlenecks); (LPSI_3) our subsidiary often performs the development of new production processes; (LPSI_4) our subsidiary often develops advanced tools of process management; (LPSI_5) our subsidiary often performs the implementation of innovation projects and process improvement (Cronbach Alpha of 0.913).

Again based on Iammarino et al. (2008), the independent construct of Local Product Innovation (LPDI) was built through the following questions: (LPDI_1) our subsidiary often performs small adjustments in existing product technology; (LPDI_2) our subsidiary often carries significant improvement in existing products (specifications, features and functions); (LPDI_3) our subsidiary often performs plans, models, instructions, plants, technical drawings, and/or prototypes to design new products; (LPDI_4) our subsidiary often performs implementation of innovation projects and product improvement (Cronbach Alpha of 0.935).

Finally, the mediator construct of Local R&D Innovation (LRDI) (von Zedtwitz et al., 2004) was built through the following questions: (LRDI_1) our subsidiary often conducts research and development activities; (LRDI_2) our subsidiary often develops or contract R&D projects and/or innovation in partnership with other institutions in Brazil (internal R&D); (LRDI_3) our

subsidiary often develops or contract R&D projects and/or innovation in partnership with foreign institutions outside Brazil (external R&D) (Cronbach Alpha of 0.794).

The research model is shown in Figure 1:

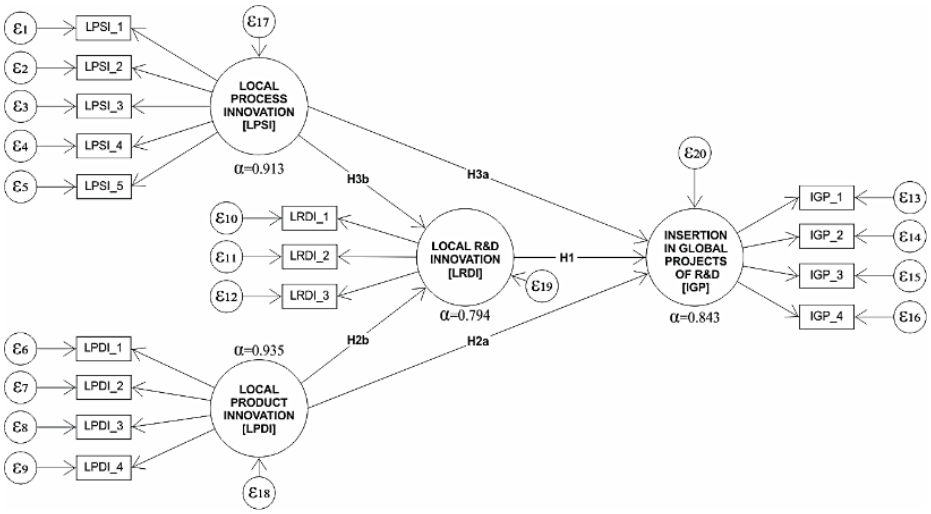

Figure 1: Investigative Model
Source: The authors

4. RESULTS AND ANALYSIS

Our results show in Table 2 the means and standard deviation of all constructs after Pearson's correlation. The coefficients shown assume that there is a linearity of the data, by the positive result of all the coefficients and values smaller than 0.85 with a significance of p <0.001.

Table 2: Correlation Analysis

	Mean	Standard Deviation	IGP	LRDI	LPSI	LPDI
IGP	2.76	1.32	1			
LRDI	2.97	1.29	0.656**	1		
LPSI	3.65	1.17	0.553**	0.662**	1	
LPDI	3.36	1.42	0.568**	0.686**	0.763**	1

Source: The authors. **The correlation is significant in the level 0.01

The measurement model is associated with the accuracy (validity) and consistency (reliability) of the variables (Hair, 2010). Table 3 presents the results regarding the reliability of the internal consistency, the convergent and discriminant validity of the proposed measurement model. To measure the reliability of the internal consistency of the variables, the coefficient alpha (Cronbach's Alpha) was used. Cronbach's alpha results, above 0.7 and below 0.95, allow us to conclude that there is internal consistency in the model.

To evaluate the convergent validity, the average variance extracted - AVE is used, and it is expected that the higher the variance extracted, the more representative the indicators of the construct are, and an index higher than 0.50 is suggested (Hair, 2010). In the analysis of discriminant validity, the AVE is compared between constructs of different theoretical bases and is expected to have a low correlation (Hair, 2010).

From the results in Table 3, it is shown that all the constructs presented AVE above 0.5, confirming the convergent validity for the constructs in the measurement model.

The composite reliability of Dillon-Goldstein's Rho_A standardized and non-standardized (composite reliability), above 0.7 allows concluding that the constructs are homogeneous (Werts, Linn, & Jöreskog, 1974).

Table 3: Reliability Measures and Discriminant validation by Fornell and Lacker's (1981) criteria

	α^a	Rho_A[b]	Rho_A[b]	AVE[d]	IGP	LRDI	LPSI	LPDI
IGP	0.843	0.845	0.905	0.762	**0.873**	-	-	-
LRDI	0.794	0.797	0.879	0.708	0.656	**0.841**	-	-
LPSI	0.913	0.929	0.935	0.744	0.553	0.662	**0.862**	-
LPDI	0.935	0.939	0.953	0.836	0.568	0.686	0.763	**0.914**

Source: The authors. (a) Cronbach's alpha; (b) composite reliability (unstandardized); (c) composite reliability (standardized); (d) Average Variance Extracted

In order to apply the discriminant validation of the measurement model, the Fornell-Larcker criterion was applied, which allows the comparison between the square root AVE and the correlations between the latent variable constructs. For validation, the comparison between the results of stroke and correlation should indicate that the square root of the AVE of each construct is greater than the correlations between it and the others (Hair Jr, Hult, Ringle, & Sarstedt, 2014). Table 3 also presents the correlation results of the variables of the model, compared to the square root of AVE in focus.

Table 4: Hypotheses test

Hypotheses	Relationship between constructs	λ[a]	t[b]	Sig. (ρ)[c]	Results
H1	LRDI → IGP	0.470	4.674	0.000	Supported
H2a	LPSI → IGP	0.130	1.297	0.195	**Not Supported**
H2b	LPSI → LRDI → IGP	0.331	3.398	0.001	Supported
H3a	LPDI → IGP	0.146	1.551	0.122	**Not Supported**
H3b	LPDI → LRDI → IGP	0.433	4.561	0.000	Supported

Source: The authors | **Notes**: (a) Standardized load; (b) T statistics; (c) significance level < 0.05 and p <0.01

Table 5: Determination coefficient

	R Square	R Square Adjusted
IGP	0.463	0.451
LRDI	0.516	0.509

Source: The authors

The results presented in table 4 show the tests of significance of the hypotheses proposed. Three of the hypotheses were supported: H1, H2b, and H3b (p <0.001). The values presented in column "t" (T-Statistics) are higher than 2.57 (level of significance = 0.01), and it can be concluded that the model loads are also highly significant.

For the other unsupported hypotheses (H2a and H3a), the results suggest that in emerging markets, such as Brazil, if local capacities in processes and products are only developed at the levels of basic and intermediate technological capacity (Iammarino et al., 2008), these will not be significant for the subsidiary to be included in global innovation projects.

The coefficient of determination of the model (adjusted R2) was 0.451, which allows us to conclude that the three latent variables tested (LPSI, LPDI, and LRDI) explain the degree of explanation of the variance of the endogenous IGP variable, according to Table 5, 1% of the IGP variance. On the other hand, the LPSI and LPDI variables account for about 50.9% of the IGP variance (adjusted R2 = 0.509).

These results corroborate to the argument that the insertion of foreign subsidiaries in Brazil into global projects occurs through the development of local capacities in processes and products and in parallel, the subsidiaries are involved in internal and external R&D activities.

The next two tables show results of the hypothesis and the model's coefficient of determination:

Therefore, we can say that the insertion of foreign subsidiaries operating in Brazil in global projects is associated with the accumulation of local capabilities in the process, product and R&D innovation and there is a positive interaction effect between local capabilities of processes and product and local capabilities of R&D innovation of foreign subsidiaries operating in Brazil.

5. DISCUSSION

The analysis of the results of the confirmed assumptions suggests that for insertion of their organizations in global projects, the subsidiaries installed in Brazil must build up local capacities of innovation in products and processes, as well as technological innovations of low, medium or high complexity (Iammarino et al., 2008). These findings collaborate with the evolutionary theory suggested by Bell and Figueiredo (2012) and he studies of the evolution of the subsidiaries' performance in emerging countries, from just passive followers of the innovations originated in the array organization to local innovation agents and the interface

between the local economy and the global innovation networks (Birkinshaw & Hood, 1998). The subsidiaries become participants in global innovation projects through the build-up of local capabilities (Khayyat & Lee, 2015).

The results support the hypothesis H1 and show that there is an association between the local capacity for innovation of R&D and the insertion in global projects. Despite R&D not being intense activities in emerging markets (Altenburg et al., 2008; Y.-C. Chen, 2008), they bring benefits vis-à-vis to the absorption of advanced technologies and the use of knowledge obtained from the organization for the construction of local innovation capabilities (Altenburg et al., 2008). In particular, the confirmatory evidence of hypothesis H2b an H2b in the Brazilian subsidiaries shows that at least for the innovation process and product there is a positive interaction of R&D activities to enhance local capacities making them more robust and with global potential. Therefore, mostly, the results show that the insertion in global projects by the Brazilian subsidiaries happens by processes, product and R&D innovation, and with the close interaction between the subsidiary and the matrix. This is important to be highlighted and explored by the subsidiaries established in the country, because there seems to be a great opportunity if the strategic approach to innovation through of a path of cost reduction of solutions, through incremental innovations and process learning (von Zedtwitz et al., 2015; Zeschky, Winterhalter, & Gassmann, 2014).

The hypothesis H2b is aligned with the research to develop new products in emerging countries and in Brazil (Marin & Bell, 2010; Marin & Costa, 2013) and the consequent participation in global projects (Lema et al., 2015). The results supported by research shows that through local innovations and access to distinct sources of technology available at local and external specialized innovation centers (Qiu & Cantwell, 2018), the foreign subsidiaries in Brazil are moving away from a support posture to acting proactively in their own choices of paths of innovation (Bell & Figueiredo, 2012; Marin & Sasidharan, 2010). Considering the ways to build local capacities (Eppinger & Chitkara, 2006) of low cost, process improvement, global growth in the face of market and integration of technologies, results show that Brazil has been chosen to receive the areas of product development of subsidiaries of multinational.

The results allow us to confirm that the association between R&D and insertion in global projects when we refer to product innovation contradicts a remnant view of Brazilian subsidiaries only low cost or contribution centers, but not of creating new products. The established alignment between R&D and local product capabilities reinforces the evidence that R&D centers in emerging markets can go beyond product adaptations with innovations that can be globally embedded (Y.-C. Chen, 2008; von Zedtwitz et al., 2015). In other words, the scope of product development activities in these countries can be directed to research geared towards global innovation.

The hypothesis H3a supports the development of local capabilities for processes focused on cost reduction, optimization of the features, or new features at low cost. Innovations in processes in emerging markets, initially developed in the subsidiaries to serve the local market, have become suitable for the commercialization in other markets, either emerging or developed (Zeschky, Widenmayer, et al., 2014). The development of innovation capabilities to meet these local markets and the accumulation of these capacities (H3a) based on technical improvement of local expertise of subsidiaries (Schreiber, 2008) supports the different bases of skills, relationships and institutional frameworks necessary to participate in the routes of innovation and, consequently, to the transition from imitators to innovators (Choung, Hwang, & Song, 2014).

The results of the H3b hypothesis demonstrate that the insertion in global projects of local capacities in processes for subsidiaries in emerging countries are both a result of the evolution of the accumulation of production capacities, and participation in global projects (Figueiredo, 2014) interaction between competencies and diversified technological innovation activity

profiles of geographically districted R&D centers in local and international interactions with the subsidiary (Qiu & Cantwell, 2018).

Compared to subsidies in developed countries, the results reflect the technological frontier differences in emerging countries. In developed country subsidies, because they already operate with innovation capabilities from the technological frontier of innovation, and supported by the innovation collaboration network with suppliers (Almeida & Phene, 2004; Andersson, Forsgren, & Holm, 2002), researchers innovation, and measure innovation performance based on R&D and patent activities and expenditures (Figueiredo et al., 2010).

For the subsidiaries in emerging countries, the technological specialization in innovation capacities comes from efforts in the management of knowledge integration mechanisms (Bell & Figueiredo, 2012), which are dispersed in the local R&D centers, both internal and external to the subsidiary, basic and intermediate production capacities reach the level of advanced technological complexity of innovation with a tendency to be inserted into global projects.

6. CONCLUSIONS AND CONTRIBUTIONS

The results contribute to the view of subsidiaries as a potential and active resource for innovation within global innovation networks, as well as occupy a position within the hierarchy of the organization, acting locally and globally (Figueiredo et al., 2010).

Previous studies on multinationals contribute to the debate and understanding of the participation of subsidiaries in industrial progress in emerging countries, but limited research is presented on innovation activities related to capacity building and their relationship to participation in global innovation networks (Bell & Figueiredo, 2012). The study of these relationships and the intensity and nature of technological capabilities contribute to the literature by presenting the integration of the subsidiary with external and internal sources of knowledge (universities, research institutes, and other companies) as mechanisms for transferring learning and building local capacities that provide the insertion in global R&D projects.

The article presents information about types of innovation capability that must be developed for the participation of the subsidiaries of emerging markets in global innovation projects, more specifically those installed in Brazil. It reinforces the role of foreign R&D centers as a source of value creation through its capabilities (Frost, Birkinshaw, & Ensign, 2002), and the importance of subsidiaries in skills development (Cantwell & Mudambi, 2005; Kuemmerle, 1997). The results show the importance of knowledge sharing (Adams, Brusoni, & Malerba, 2011) among subsidiaries, research centers in companies, universities, and R&D centers external, for insertion in global R&D projects.

6.1 Theoretical implications

As a contribution to the academic debate, firstly, this article contributes to the development of local innovation capabilities by foreign subsidiaries in Brazil and indicates the global capabilities of products and processes, separately, are a source of global growth (von Zedtwitz et al., 2004). Second, the article contributes to studies that indicate the potential of emerging markets in the field of innovation in emerging countries (Govindarajan & Ramamurti, 2011)a. However, when analyzing specifically the interaction between R&D and processes and product, this research points to the strategic direction of R&D activities in conjunction with local and external collaborators to evolve basic and intermediate technological capabilities based on existing technologies for production of goods, to a strong regional innovation system based on relationships and attributes (Iammarino et al., 2008).

One of the theoretical contributions of this research is technological capacity indicator, defined by Iammarino et al. (2008) to analyze relationship levels from global and local interactions, measuring basic, intermediate and advanced capacities of process innovation and products applied to local innovation capacity constructs to the subsidiaries installed in emerging markets and the insertion of these capacities in global projects.

As presented by Figueiredo (2008) and Iammarino et al. (2008), the results of this research were based on differences in novelty levels and innovation activities that determine innovation performance but contributes to considering these differences the variables that influence the intensity of the integration of subsidiaries into global projects.

The positive results of this research on the hypothesis of insertion relationship in global projects from local process capacity development confirm the role of the subsidiaries in emerging countries. For these subsidiaries, there is an evolution of accumulation of production capacities and participation in the global network of production from the accumulation of innovation capacity, although this relation is not linear (Figueiredo et al., 2010). However, the integration of internal rooting within the multinational's network of basic and intermediate competencies with rooting in the local and international system of R&D centers, through learning mechanisms (Bell, 2007; Marin & Bell, 2010) subsidiary to be more innovative and consequently to be inserted into global innovation projects.

The interaction of innovation capacities in R&D in the relationship between local innovation product capacities and insertion in global projects contributes to Figueiredo's (2014, 2016) debate by presenting more comprehensive results on how the nature of innovation capacities in emerging markets does not merely reflect activities and R&D and patents but relates to different innovative activities and technological functions. For the emerging countries, as shown in this research, the opportunity to access new knowledge in research centers, universities and other companies (Qiu & Cantwell, 2018), and integrates them with the capacities built in the internal network of the multinational through the mechanisms of learning, it is crucial for the subsidiaries established in these countries to be included in global innovation projects.

Patel and Pavitt (1998), for developed markets, have already warned about the risk of concentrating the interpretation of innovation capacity in the R&D measures of the organization to the detriment of other technological activities present in the process of transforming the organization in the development of new products. In the case of developing countries, innovation capabilities allow innovative activities to take place in the subsidiaries if they are technologically advanced capabilities, developed by the diversification of sources and knowledge (Iammarino et al., 2008; Marin & Giuliani, 2011; Qiu & Cantwell, 2018).

In this way, in the emerging countries, innovation must be understood in its multiplicity and activities, and not only in R&D activities developed internally. On the other hand, the interaction of innovation capacities in R&D in the insertion of local product capacities in global projects also points to an alert about the necessity of mechanisms of accumulation, integration and technological capabilities present in the partnerships with universities and research institutes local and external to generate innovation (Figueiredo, 2014).

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