GLOBAL R&D OF VOLKSWAGEN: LOCATION STRATEGY IN EMERGING MARKETS.

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INTRODUCTION

Research and development (R&D) is one of the main functions of a company, and, traditionally, large multinational enterprises (MNEs) have kept it internally. R&D internationalization only occurred when it was necessary to access specific technologies or knowledge, and, in general, developed countries carried out these innovation activities (Zedtwitz & Gassmann, 2002). MNEs from advanced countries were pioneers in this trend, orchestrating global R&D networks that coordinate the innovation flows within their subsidiaries. The traditional approach was first to create and launch products in the home country, and later take these new products and technologies to subsidiaries in less developed countries (Filatotchev & Piesse, 2009), which we here call emerging countries. However, in the past two decades, the origin and direction of international innovation has radically changed.

Since the end of the 1990s, studies began to mention a process of R&D internationalization in several industries, from headquarters in developed countries to subsidiaries in emerging countries. Confirming this trend, data from Global R&D and Innovation [Glorad] on location of R&D in 2016 show that, between 2000 and 2015, the number of research centers in emerging countries grew five times, while in the Triad countries (United States, Western Europe, and Japan) that number just doubled (Glorad, 2020). In the last 20 years, there are several examples of products created and introduced in the market by an MNE subsidiary in emerging countries, and only later launched in developed countries (Zedtwitz *et al*, 2014; Govindarajan & Trimble, 2012).

MNEs do not go to emerging countries just because of lower costs of R&D activities (Zedtwitz & Gassmann, 2016). They use this opportunity also to update their global R&D profile. Their investment in emerging countries' R&D has a spillover effect that not only helps these countries build their own R&D capacity, but also increases the company's global R&D capacity by integrating these capabilities (Qi, Wang, Zhang, & Zhu, 2014). Therefore, the company has access to local talents and transfers technology from subsidiaries.

The internationalization of such activities aims primarily to expand a company's innovation capacity, by accessing geographically dispersed knowledge, as well as diversify and complement its technologies, which increases its competitiveness in global markets (Awate, Larsen, & Mudambi, 2015; Hsu, Lien, & Chen, 2014). The multinational's headquarters coordinates the network, which integrates all knowledge created by R&D in the various subsidiaries, in order to develop a higher innovation capacity (Mudambi & Navarra, 2004). The new R&D centers in some emerging countries have modern and technologically sophisticated facilities, besides employing talented professionals, fully focused on new applications and technologies that are only feasible in low-cost countries (Zedtwitz & Gassmann, 2016).

There are many studies on R&D internationalization, and most of them relate it with innovation capacity (Hsu *et al.*, 2014). The literature mainly addresses the Triad countries, discussing companies' motivations to transfer their R&D activities abroad (Gassmann & Han, 2004), and their skills to implement R&D activities at these new locations (Cantwell & Mudambi, 2005). Another frequent focus of studies is the geographical dispersion and development models of R&D internationalization (Asakawa, 2001; Fisch, 2003; Gassmann & Zedtwitz, 1999). In this perspective, Zedtwitz and Gassmann (2002) established primary models for R&D internationalization, considering specific factors such as talent availability, engagement and scientific cooperation, operational efficiency, costs, etc., in addition to factors external to R&D, such as the host country's level of development, confidentiality, and stability of local policies.

Some studies examined the impact of variables regarding the home and host countries, the industry, and the company, for choosing location (Demirbag & Glaister, 2010). However, the literature has focused on the traditional meaning of R&D internationalization, that is, the allocation of activities defined by headquarters established in developed countries to subsidiaries in emerging countries. There are few articles that analyze how subsidiaries' organizational aspects, the company's global strategy, and the local attributes of host countries affect the decisions to locate R&D in emerging countries and their capacity for local innovation. This article seeks to fill this gap.

THEORETICAL BACKGROUND

R&D Internationalization

The literature on R&D internationalization is quite large, and several studies show a growing trend of this process in different economic sectors. The focus of such studies are companies' motivations to transfer their R&D activities abroad, mainly to subsidiaries in developing countries (Gassmann & Han, 2004; Zander, McDougall-Covin, & Rose, 2015), and their skills to implement R&D activities abroad (Cantwell & Mudambi, 2005). Other authors address the geographical dispersion and development models of R&D internationalization (Asakawa, 2001; Fisch, 2003; Gassmann & Zedtwitz, 1999).Regarding the results of the R&D internationalization process, it facilitates MNEs' innovation system, while encouraging the diffusion of innovations between headquarters and their subsidiaries (Cantwell & Mudambi, 2005; Cantwell & Zhang, 2006), which promotes and sustains a competitive advantage in international markets (Kafouros *et al.*, 2008). Several authors observe that MNCs can increase their competitive advantage in global markets by dispersing their creative activities among several centers of excellence, while keeping a centralized coordination of all knowledge created by different centers (Lorenzen, 2005). This means that, in order to understand the effects of dispersion on the creation and use of intellectual assets, it is necessary to relate them to the optimization decisions made by headquarters (Mudambi, 2008). To this author, a creative and innovative MNE prioritizes two fundamental aspects: the control and location of the most important activities of its value chain, that is, the degree of geographical dispersion of R&D activities and the resulting innovation initiatives. According to traditional and until recently prevailing standards, advanced market economies concentrated R&D location and other activities with high value added, while activities with low value added were conducted in emerging countries. However, that has quite changed.

The establishment of international R&D networks and the management of transnational R&D projects are high-risk projects. The main challenges are the physical distance among the different R&D units, as well as the distance between these units and headquarters. This affects the frequency and quality of communication among the parties, besides increasing transaction costs. Hence, issues of coordination and control can prevent exploiting the effects of potential synergy. By their very nature, managing transnational projects is more difficult than coordinating local projects. The exchange of data and information cannot occur at the same speed and with the same level of quality. In addition, constant international travels create a high degree of physical and emotional stress for project managers. Despite new and modern means of communication, the exchange of tacit knowledge, the creation of mutual trust, and a common work culture require face-to-face communication (Zedtwitz & Gassmann, 2016). Therefore, location factors and managerial aspects are determinants for R&D decentralization (Mudambi, 2008).

The term R&D leads us to disregard the differences between Research and Development. The needs of science for research activities, compared to the needs of development, result in

different management issues. Most of the contributions that distinguish research from development neglect the international dimension. The transfer of knowledge are the main managerial challenges in the international R&D context (Zedtwitz, Gassmann, 2002).
In general, company's top management makes the decision on where to establish a new R&D unit, after consulting the corporate strategy and R&D departments, and considering specific factors of R&D units. These comprise the quality of inputs in the new country (talent availability, local scientific cooperation), the quality of expected results (cooperation with local customers, local developments, proximity to the market), in addition to general operational efficiency (economies of scale, project delivery, cost issues). Factors external to R&D also affect location decisions, such as host country's level of development, market size, confidentiality, and stability of local policies and social systems (Zedtwitz & Gassmann, 2002). These authors, in a survey with 1,021 R&D areas, identified four patterns of international R&D dispersion: a) **National Treasury** (domestic research and domestic development) - R&D activities are kept exclusively at headquarters, with a centralized management, and collaboration of some foreign experts, for advice or consulting; b) **Technology-oriented R&D** (dispersed research and domestic development) - development remains centralized, due to several factors, including the scale effect in the development process, proximity to the control and decision-making center, synergy effects, and high costs of coordination and control associated with international R&D projects; c) **Market-oriented R&D** (domestic research and dispersed development) - business development is dominated by customer demand and not scientific exploration; d) **Global R&D** (dispersed research and dispersed development) - global companies distribute research and development in several countries, and headquarters is responsible for the global coordination of R&D activities. Most of them have characteristics of integrated R&D networks.
These four models were decisive for explaining internationalization processes in early 2000s. However, as organizations changed their R&D strategies and with the significant growth of emerging economies, those four patterns were no longer sufficient to explain all modes of operation. Therefore, Zedtwitz and Gassmann updated their study in 2016, by considering five typical configurations for R&D internationalization and their evolution over time. Figure 1 summarizes them:
a) **Do-alone R&D** - R&D activities are concentrated at headquarters;
b) **Open Collaboration R&D** - as organizations internationalize, expanding into new markets, they have support of new providers of specialized technology. They look overseas, seeking partnerships in R&D with universities and research laboratories, and joint ventures with local firms for product development, focusing on innovation;
c) **R&D Hub** - if markets are large enough to host subsidiaries, the local units start R&D processes to adapt products and to develop new local products. In sectors with an efficient use of technological platforms - such as the **automotive industry** - this is the usual configuration;
d) **Multi-node R&D** - in some MNEs, market orientation is so intense that all activities are local, with only a few functions reporting to headquarters. R&D units develop products for local customers, without much interference, and without headquarters' coordination;
e) **Integrated R&D Network** - in this model, each R&D center is an individual center of excellence, and innovation results from the global interaction of all centers, under the leadership of a head that meets the company's global needs, operating in multiple markets simultaneously. Pharmaceutical and telecommunications industries normally fit into this model, as they have high innovation rates (Zedtwitz & Gassmann, 2016). We chose this model in this article.

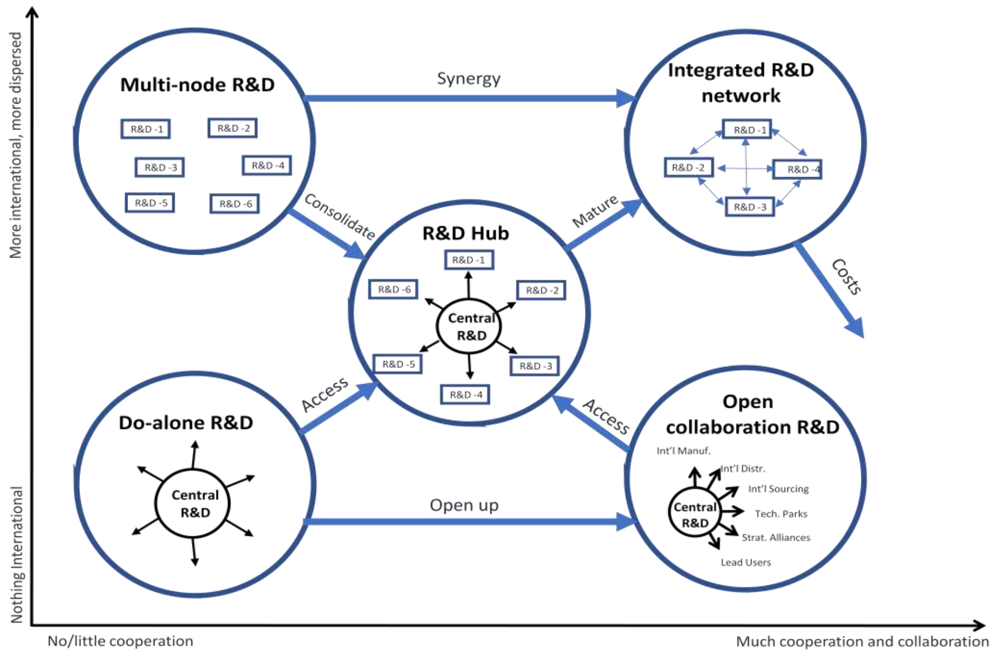

Figure 1. Organizational structures for R&D internationalization
Source: Zedtwitz & Gassmann (2016, p.128)

***R&D Internationalization and innovation capacity*.**

Most of the published articles correlate R&D internationalization with innovation. As firms internationalize their research and development activities in several countries, particularly advanced economies' MNEs, they strengthen their technological capabilities, improving the efficiency of their products and facilitating new developments, thereby fostering innovation (Hsu *et al.,* 2014). Qi *et al*. (2014) examined R&D activities of Motorola's subsidiary in Beijing, from 1998 to 2008, and showed its evolutionary process, through four stages:

a) *Local adaptation unit*, which carried out simple and adaptive tasks for the local market;
b) *Local development unit*, with independent product development activities;
c) *Global R&D center*, as a module of global projects for the global market; and
d) *Global integration center*, playing a leading role and central coordination of global projects for the global market.

Pogrebnyakov and Kristensen (2011) considered two types of subsidiaries - implementer and innovator - and showed how to move from one type to the other. They studied the experience of Novo Nordisk, a large Danish pharmaceutical. The change must start as a strategic priority within the company, and then translate into specific actions; every subsidiary in an emerging country starts as an implementer, and several achieve the position of innovator.

An implementing subsidiary prioritizes a single innovation, often a small part, just one stage of the innovation process, but not the innovation management; that is, it does not develop its own innovation processes. It adopts the innovation processes provided by other areas, but contributes actively to the company's innovation results. On the other hand, an innovative subsidiary has a highly developed capacity to manage the whole innovation process. It participates in several stages and can manage implementing subsidiaries. It transfers the processes it develops, as well as innovation results, to other parts of the company.

The main difference between them is not the quality of the innovation result, but the ability to orchestrate complex innovation processes, over several stages, which may involve different R&D subsidiaries. Both types are part of a *continuum;* in practice, a subsidiary may have elements of both, as it develops innovation management capabilities over time.

Athreye, Tuncay-Celikel and Ujjual (2014), in an article on Fiat's R&D internationalization in Brazil, India, and Turkey, mention "competence-creating subsidiaries", which promote innovations more than sales, pointing out optimistic and pessimistic views of this phenomenon. Pessimistic authors still observe nowadays that the generation of technological knowledge prevails in developed countries, and that orchestrating global innovation requires complex management. However, optimists think that there are great rewards for the effective management of competence-creating subsidiaries in different countries. The multinational may have an ideal configuration of **R&D Hub**, according to Zedtwitz and Gassmann (2016).

Not all subsidiaries will have an equal role in carrying out R&D. Their level of capacity and the strategic relevance of local markets will determine it.

Quadros and Consoni (2009), in a study on Brazilian subsidiaries of European multinationals, observe that the capabilities for product development vary with increasing demand and the consequent scale of production. When MNEs establish R&D operations in subsidiaries located in emerging markets, they gain access to different national innovation systems, which facilitates their technological adjustment to these markets, and create new strategic alliances with customers, competitors, universities, and research institutes (Awate, Larsen, & Mudambi, 2012). The focus of R&D internationalization is to enhance companies' innovation capacity for developing new or improved products, services, and processes (Awate *et al.*, 2012; Bell & Pavitt, 1993; Brusoni, Prencipe & Pavitt, 2001). In general, EMNs headquarters is the network coordinator, and integrates all intra-organizational knowledge created in the subsidiaries, in order to develop a stronger innovation capacity (Mudambi & Navarra, 2004).

One of the great challenges that global companies face is to reconcile the needs of local innovation with the requirements of global innovation. The subsidiary develops local innovation to meet the needs and demands of the market where it operates. It is inherent to that purpose, and difficult to transfer to headquarters or to another subsidiary, since the efforts to adapt and align it with the MNE global processes and strategies are complex and costly. However, in some situations, global innovation can first serve the subsidiary's local market, and then it will make an effort to adapt the innovation to the processes and strategies of other subsidiaries and of headquarters itself. Global innovation can also result from an internal demand of the MNE (Costa, Borini, & Amatucci, 2013).

In the past two decades, the origin and direction of international innovation has changed radically. The world has currently products introduced in the market for the first time in emerging countries, and only later in developed countries, and this is due to the phenomenon known as Reverse Innovation (Zedtwitz *et al.*, 2014; Govindarajan & Trimble, 2012).

The rise of emerging countries has attracted management scholars to investigate their role in R&D and global innovations. Until a few decades ago, new technologies were developed and launched for the first time in advanced countries, and only later, when they became mature, outdated were they sold in less developed countries. Therefore, the innovation flow went from advanced to developing countries. However, recent examples of products first introduced in these countries and only later in advanced countries have challenged this paradigm.

From this emerged the concept of reverse innovation, which refers to innovation first developed in an emerging country, and only later introduced in developed countries (Zedtwitz *et al.*, 2014). Emerging countries' share of world GDP has grown significantly over the past 50 years. At the same time, the proportion of patents generated in these countries has doubled compared to developed countries. As a result, multinationals in emerging countries are standing out in global research and development, and this explains reverse innovation.

Zedtwitz *et al*. (2014) present some of the factors that explain reverse innovation:

a) Companies no longer see their home countries as their main markets;

b) Product development and R&D are not exclusive to advanced countries;

c) Products developed in and for emerging countries are, eventually, better than those from advanced markets;

d) Companies from developing countries seek not only to develop, but also to conceive ideas for products, based on their own technologies and scientific insights.
Reverse innovation will be more robust as the number of reverse flows increase.

METHOD

We chose a qualitative methodology and a case study approach, according to Eisenhardt (1989). This is appropriate, since we built propositions that can serve as a first step of a later and more extensive hypotheses test study.
The automotive industry gave rise to several concepts relevant to modern management, such as “Fordism” and lean production processes. Therefore, it is an influential and trend-setting industry, and symbolizes modern networked business relationships, orchestrated by MNEs (Hertenstein & Williamson, 2018). Hence, this study can provide information on how companies are involved in product development processes in these business networks, and the implications that result from different R&D configurations.
Regarding the case study, we chose the Volkswagen group to carry out the research. It is one of the world three largest automotive manufacturers, with more than 11 million vehicles produced in 2018 (OICA, 2019), and a revenue exceeding 236 billion dollars that year (Statista, 2019). The group has 660,000 employees in 122 manufacturing plants, in 31 countries (Volkswagen, 2020). With an annual R&D budget above US$ 15 billion, Volkswagen is one of the most innovative and technologically advanced automakers in the world. It has knowledge and capabilities in a variety of technologies, including power drives, chassis development, power train integration, driver comfort, safety and driving experience; more recently, it started to invest in R&D of electric and autonomous vehicles (Hertenstein & Williamson, 2018). Hence, the research context is the automotive industry in the emerging countries where Volkswagen has operations and carries out R&D activities, such as China, Brazil, India, Mexico and Eastern Europe, in addition to its headquarters in Germany that centralizes and coordinates the group’s activities, making key decisions of internationalization and R&D location.

Data Collection

We triangulated data from three different sources (Eisenhardt, 1989). First, we conducted multiple semi-structured interviews, with professionals who had full knowledge of the R&D areas, as well as of the internal and external knowledge flows of each subsidiary and of headquarters. These professionals were the most qualified for discussing the reasons that lead the company to make decisions about R&D internationalization processes. In order to avoid bias and ensure that answers were compatible with reality, and that we could check them, we interviewed at least one top executive from each foreign unit linked to the company's R&D processes, in addition to an executive at headquarters. The interviews served to compare the main individual perceptions and guarantee the group's vision.
To carry out the case study, we created a protocol (Yin, 2003). We conducted interviews with Volkswagen top executives between July 2019 and January 2020, recorded and transcribed them. Interviews in Brazil were face-to-face, and those in China, Mexico, India, and Germany were by videoconference.

Data Analysis

Later, we complemented information with internal documents provided by the company during the interviews, as well as data available on specialized websites, in addition to interviews with Volkswagen’s top management executives available on the internet. We developed the propositions inductively, and overlapped them to data collection and analysis. As the interviews started, we continuously adjusted the research protocol. Thus, three stages emerged, following standard procedures for data analysis in case studies (Eisenhardt, 1989).

In the first stage, we analyzed the subsidiaries individually, and codified the text material according to previously established theoretical categories. At this phase, we wrote a longitudinal history of each subsidiary (Yin, 2003).
Second, we conducted a cross-analysis to identify the critical reasons that led to the decision of creating these subsidiaries abroad. To do this, we designed tables with data for each case, for each theoretical category, and compared the cases among these categories, looking for similarities and differences, including the comparison between data from the different subsidiaries and from headquarters.
Then, we triangulated the results of the interviews with the internal documents and secondary data that we had systematically collected. Temporary propositions emerged from data analysis. We constantly compared the conclusions with the collected data and relevant theories, which resulted in a continuous refinement of the propositions.
Table 1 presents the summary of data collection. We gathered information on Eastern Europe from interviews with executives from the countries addressed in the study. They spontaneously mentioned those other R&D centers, and we decided to include them.

Data for triangulation of results

	Triangulation	Germany	China	Brazil	India	Mexico	Eastern Europe	Others
Primary data	Interviews	- R&D Manager	- Head of R&D Brand Jetta	-Head of R&D Brazil and - Director of Product Strategy for South America	- Manager of Product Strategy	- Director of Product Strategy	From interviews with executives from Germany, Brazil, China and Mexico	From interviews with executives from Germany, Brazil, China and Mexico
	Duration of interview	3h	1h	2 h; 2h	1h	1h	-	-
Secondary data	Company's materials	Product development process - group (valid for all except China)	Product development process - group (specific China)	Product development process - group Design Process	Product development process - group	Product development process - group	Product development process - group	Product development process - group
	Public Institutional Report	Group revenue R&D expenses R&D expenses / revenue	VW revenue in China R&D expenses in China	Factories, production volume and sales	Factories, production volume and sales	Factories, production volume and sales	Factories, production volume and sales	Factories, production volume and sales
	Media interviews	Group CEO in a speech at IAA 2019 (link available)	Group CEO and president of VW China – interview to CGTN 10/2019 (link available)	Group CEO Interview at Linkedin (link available)	Interviews CEO Škoda India (link available)	Speech of President of VWAG council and President Mexico (link available)	Interviews with CEO Škoda (link available)	Interview with President of VW South Africa (link available)

Table 1 – source Authors

RESULTS

Description of Volkswagen's Global R&D

The Volkswagen Group reinvested about 7% of all 2018 revenues in R&D activities, confirming the importance given to R&D and innovation processes.
The main R&D center is located at headquarters, in Wolfsburg, Germany, and has more than 7,000 engineers. It carries out most of the company's research, the exclusive development of platforms, as well as all activities related to development, such as design, vehicle safety, crash test, prototypes, physical and mathematical models, etc. The center focuses its R&D efforts on electric cars, autonomous cars, and connectivity.
The group's second largest R&D center is in China, where there are two units, one to the north, in Changchun, and one to the south, in Shanghai. They together employ more than

3,000 engineers. This center has already developed vehicles exclusively for the Chinese market, such as Santana and Gotham, but it does not have a design area (except for colors and fabrics), nor a crash test area. Chinese R&D centers do not develop platforms.

The oldest R&D center of the Volkswagen group outside Germany is located in Brazil. This unit conducts some research, and stands out in biofuel technology R&D. It has around 1,000 engineers, and is the best-equipped center after headquarters, with modern and complete areas of design and vehicle safety. However, as per group strategy, it does not develop platforms.

Mexico's R&D center has also over 1,000 engineers, and focuses on adapting European vehicles to American standards. The Mexican engineering area has no design center and no vehicle safety center. It has the areas of body development, finishing, interiors, engines and chassis, and electrical. It also does not develop platforms.

Technical Offices, or TOs, are distributed around the world, and always associated with production plants, in countries like India, South Africa, Russia, and Argentina. These TOs do not carry out research activities, and development is restricted to tropicalization and customization of vehicles for the local market.

The trend in Volkswagen group is towards decentralization and an increasingly intensive use of existing R&D centers at its subsidiaries, as well as the creation of new centers in strategic markets. Figure 2 summarizes the organization of the main R&D centers of the group, with their characteristics, limitations, and strategies.

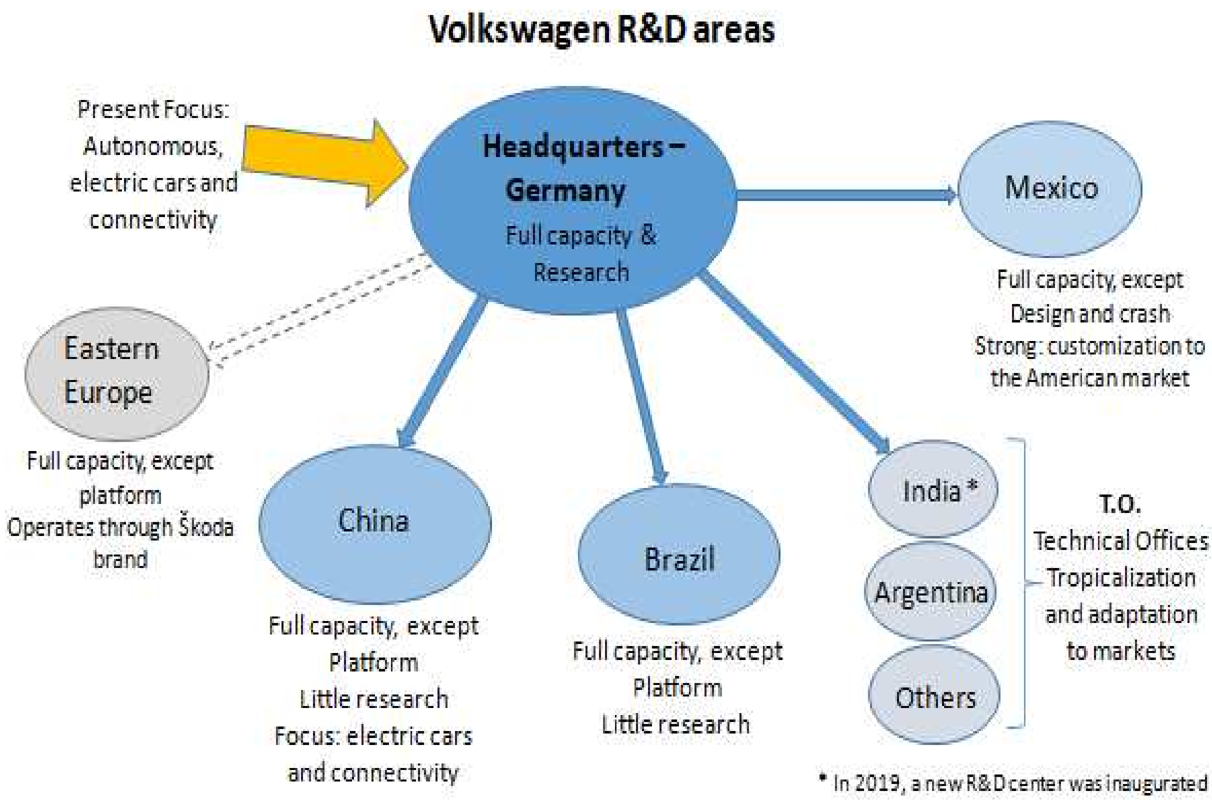

Figure 2 – Characteristics of VW's R&D centers around the world
Source: interviews and secondary data

Table 2

Main influencing factors for R&D location at the Volkswagen group

	Germany	China	Brazil	Mexico	India	Eastern Europe	Others
Organizational factors	-Full R&D -Decision on concept -Platform development -7,000 engineers -Project coordination -Product forums - Expatriation	-Full R&D except Platform, design, and crash test - 25 years of R&D -Large R&D – 3,000 engineers - *Joint venture* with local firms - 30% outsourced	- Full R&D (design + crash) except Platform -50 years of active R&D in the country - 1,000 engineers -*Know-how* through technical qualification 30% outsourced	- Full R&D except Platform, design, and crash test -Large R&D center, over 1,000 engineers - Strong German presence - 30% outsourced	- Until 2019 just TO (tech. office) - Operates through Skoda brand - Only 1% market share - New R&D center just opened, with 250 engineers.	- Full R&D (design + crash) except platforms, close to Praga - Large R&D with 2,000 engineers - Operates through Skoda brand, of Czech origin	-Presence of TOs (Technical Offices) -R&D limited structure - few engineers
Group Strategies	-Focus on electric vehicles, autonomous, and connectivity - Leads Research -Defines platforms - Brand was overtaken by Tesla in value -CEO defines focus: decentralization of R&D activities to subsidiaries with more autonomy	-Main market -Group focus -Electric cars and connectivity - Exclusive brand: Jetta, with 3 cars -Increase of autonomy with group decentralization -Reverse innovation (Santana)	- Higher autonomy with decentralization -Leadership in development of conventional vehicles (not electric) -Reverse innovation (in the past: Fox; currently: Nivus)	- Focus on US market - First customization of cars for the American market. - Future complete development of cars for the US - Reverse innovation (ongoing; car still in development)	-Expansion of R&D center -Unification of 3 brands and ‘India 2,0’ Program - Market share: from 1% to 5% until 2025 -Focus on low-cost cars	- Autonomy for Skoda brand cars. - Does not develop platforms, but influences the decisions on the group’s low-cost platforms	-Low autonomy -Focus only on locations and tropicalization -Should receive more tasks and responsibilities with group decentralization
Host country factors	-Triad country and one of the most developed in the global Auto Industry.	-Largest market -Growth potential -Low saturation -Population’s higher purchasing power -Change of *joint venture* policy -Labor cost -Competitiveness	-Relevant market -Growth potential -Low saturation -Energy matrix delays electrification -Risks related to tax policy and labor laws -Bilateral commercial agreements	-High production volume -Proximity to US -Commercial bilateral agreements -Economic stability -Low labor cost -Cultural factors in relationship with Europe	-Huge market -Growth potential -Low saturation -Low labor costs with technological competence -Competitiveness -Extreme poverty -Relevance of local Auto Industry	-Proximity to Western Europe -Access to the same European universities -Bilateral commercial agreements -Labor cheaper than in Western Europe, with the same know how	-Emerging markets and less relevant to the group (Ex. Argentina, Russia, South Africa)

Volkswagen's global R&D strategy: R&D Evolution and Trends at the Volkswagen Group

With the introduction of stricter emission standards worldwide, but mainly in Europe, the company has focused on the continuous development of more efficient engines and vehicles, including intensive research on electric cars.

> *"Volkswagen aims to achieve neutral carbon by 2050. The transportation sector produces about 14% of world CO_2 emissions. Only emissions from passenger cars of the group's brands represent one percent of that value. And we will reduce this value, step by step. Because each ton of carbon dioxide makes the earth warmer".* [Herbert Diess, VW's CEO] (VW, 2019).

Volkswagen itself plans to launch the largest fleet of electric vehicles in the world in the next decade, including 75 all-electric models and about 60 hybrid vehicles. To do this, it plans to invest € 60 billion (US$ 66.3 billion) in the next five years (Hessler, 2020).

However, a strategic condition should not change with decentralization of R&D activities. All respondents had the same perception that subsidiaries will not deal with the concept and development of platforms, even those with R&D centers with big infrastructure and expertise. A platform does not focus on a specific market, but serves the business group as a whole, and its development should meet the most diverse uses and specificities. Thus, platforms' design and development tend to remain under headquarters' control, but used worldwide. On the other hand, subsidiaries' R&D centers will have an increasingly relevant role in identifying customers' needs and preferences, providing key inputs for the creation of future platforms.

For interviewees, technological partnerships between the headquarters and the various subsidiaries should intensify, as well as among them, seeking to explore the positive attributes and expertise of each R&D center. There will be task sharing, both in specific development activities and in testing and approval routines (example: prototypes construction and test).

According to the group's CEO, Volkswagen, like other automakers, has been under pressure by increasingly stringent emission regulations. In order to comply with European legislation in the coming years, internal combustion vehicles (regardless of the fuel) will have to incorporate combustion cleaning systems for later emission into the atmosphere, such as complex catalysts, which should increase considerably their costs. On the other hand, electric vehicles do not emit pollutants into the atmosphere, but are much more expensive than conventional ones. However, the scale effect and the improvement of electric vehicles' systems tend to reduce their cost. Combining these two phenomena, it turns out that the cost difference between conventional and electric vehicles tends to decrease gradually, so that, in some years, these values should be equal. Thus, the vehicle electrification strategy for Europe and China makes sense for the group, as stated by Dr. Herbert Diess:

> *"Today, electric cars are more expensive than conventional ones. However, costs should be equivalent by 2025/2026, because costs for conventional cars are rising due to emission regulations. To achieve the emission levels in Europe, electric cars are more efficient. In Europe and China, electric cars are more appropriate to attain the goals of the Paris agreement. Therefore, having an electrification strategy is most convenient for VW".* Interview to CGTN - China, in January 2020

This strategy is already a reality at the Volkswagen group. R&D resources at headquarters and in the group are limited. The development of electric cars is complex and requires a high degree of research, experiments, empirical foundations, and validation tests. While the R&D team at headquarters in Wolfsburg is increasingly involved in the development of electric cars, autonomous vehicles, and connectivity, the development of conventional cars is delegated to other R&D centers, those with more capacity among the subsidiaries.

Thus, especially the Brazilian R&D center, which has the most complete R&D infrastructure of the group outside Europe, and will not migrate towards electrification technology in the short term, has been assigned greater responsibility and autonomy, assuming the leading role in the development of non-electric cars. The biggest example of this process is the current development of an unprecedented coupé-type vehicle, the Nivus model, derived from the Polo, which the Brazilian R&D team completely carries out, for production and sale in Brazil and Latin America. In parallel, this same team is adapting this project to European standards and requirements; after its launch in Brazil, it will be produced and sold in the demanding European market. Hence, this project is an example of reverse innovation at the group.

This same logic applies to other subsidiaries' R&D centers. A relevant example is Mexico, which, at first, adapted European cars to the American market, but later received new assignments and responsibilities. This new strategy is the result of three main factors: the need to decentralize R&D, the search for new R&D resources - given that headquarters' engineering is busy with electrification -, and the need to create new specific vehicles for the American market, and not just customization of European cars for that market.

Similarly, R&D centers in China and India have also received more responsibilities. China has the same strategic focus as headquarters - the priority development of electric cars -, and has increasing autonomy to develop its own products, considering the large volumes involved. The Indian subsidiary received the clear task of increasing the brand's market share in the country; therefore, the development of specific, low cost cars is essential. It has just established a real technological center, replacing the Technical Office that existed before. For both subsidiaries, the decentralization process will bring new challenges and responsibilities.

The design and development processes of an automobile are complex, involving several areas of the organization, and even outside of it, such as suppliers and a dealer network. In order to ensure the participation of all key functions, Volkswagen works with Simultaneous Engineering Teams (SET), with representatives from all areas, in order to reduce deadlines of project items, expanding the project scope, reducing product costs, etc. In the new Volkswagen structure, an area defines the group's global strategy. Their executives travel around the world, visiting all subsidiaries and participating in meetings *in loco* to understand the needs of each region. These inputs are later addressed at discussion and approval forums.

Usually, when a local need for new technologies or a specific product arise in a given region, R&D activities are normally carried out by the country itself. Examples are the development of bi-fuel vehicles in Brazil, the creation of an exclusive brand in China (Jetta brand), with three cars for local preferences, or simpler cars developed by Skoda for Eastern Europe.

Whenever possible, the VW group uses standardized systems and components, and platforms already developed to take advantage of the scale effect. With global projects, it encourages innovation, by using the strengths of each subsidiary. In global projects, however, organization and discipline must be even stronger.

Working globally also requires a large movement of people between headquarters and subsidiaries. Expatriation and transfer of expertise are very serious topics. Subsidiaries keep offices, or permanent front offices in Germany, and headquarters expatriates its employees to subsidiaries, usually for leadership positions.

Discussion and Theoretical Implications

This study strengthens Zedtwitz and Gassmann's conclusions (2016) on automotive industry, in general, adopting the **R&D Hub** model. The corporate R&D unit assigns to the outposts in subsidiaries the exploration of the local market and technological intelligence. Local R&D units, in turn, specialize in product functionality, and depend on guidance from headquarters' R&D center. Volkswagen makes efficient use of technological platforms, and both their research and development are almost exclusively the responsibility of headquarters. Plans coordinated by the central R&D area carried out with the support of local R&D units in different countries. Subsidiaries in countries with significant national cultures, such as China, Brazil, and Eastern Europe influence headquarters' product and platform concept decisions.

Due to differences in some operating conditions (such as stage of development, organizational structures, and resources), at distinct locations of an organization, such as headquarters and subsidiaries in emerging countries, the evolution of R&D qualification may be different, and not meet exactly headquarters' expectations (Qi *et al*., 2014). This happened with the subsidiaries of Brazil and China, the latter more advanced in electric cars.

The uncertainty and risk of the innovation process are always higher in emerging countries, given the lack of experience of the MNE in the country (Pogrebnyakov & Kristensen, 2011). VW started R&D activities in Brazil 50 years ago, and 25 in China. During this time, the company managed to overcome several obstacles, such as the lack of skills in English, and mainly in German, of potential employees, their low technical qualification, and cultural factors related to the local way of working.

We can also say that the Brazilian subsidiary has become a competence creator, according to Athreye *et al*. (2014), or an innovative subsidiary (Pogrebnyakov & Kristensen, 2011). For Qi *et al*. (2014), it is a global R&D center. According to Consoni and Quadros (2009), the increase in demand nurtured technological capabilities.

Regarding Zedtwitz and Gassmann's (2016) internationalization model, Volkswagen does not adopt a single format; instead, it varies for each stage of product development. Thus, in the steps prior to concept definition, all inputs from the subsidiaries, based on market research, specific local needs, etc, are considered, setting up a model similar to that of 'open collaboration R&D'. In the activities of product definition, concept decision, and design decision, especially when considering the concept of platforms, they use the model of 'Do-alone R&D', since headquarters make almost exclusively all development and decisions.

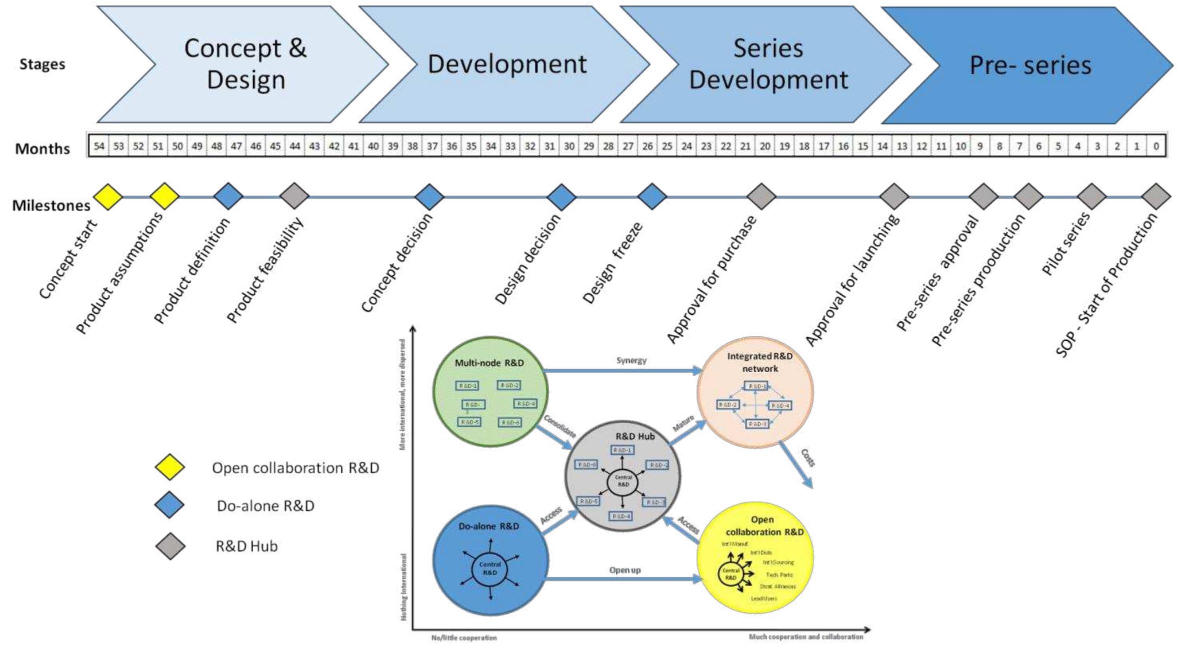

Figure 3 Development stages at Volkswagen, as Zedtwitz & Gassmann's (2016) internationalization model
Source: Interviews and secondary data

Only from the 'Design freeze' milestone, the model becomes a 'R&D Hub', where local R&D units in emerging countries carry out developments, coordinated by the central R&D area. In the first two milestones, there is Open Collaboration R&D, since specialists in the markets of all regions must necessarily provide inputs for conceptualizing a vehicle. They must consider local factors, compare with other regions, check trends, and contact universities and research laboratories for local R&D; in short, cooperate across geographical and industrial borders, with a focus on internal innovation. The 'Product definition' milestone is led and approved by headquarters, therefore it is a **Do-alone R&D** model (Zedtwitz & Gassmann, 2016), by conceiving platforms that can achieve the largest global product coverage, as well as processes that can be manufactured in different regions, with the best costs. Concept and design decisions are also exclusive to headquarters, although with the participation of representatives from different regions. The ‘Product feasibility’ milestone, although coordinated by headquarters, requires the active participation of subsidiaries' R&D centers, since their expertise is essential for defining the best technical solutions for the product’s coverage in the markets, cost reduction, and manufacturing capacity. These are the attributes of the **R&D Hub** model of Zedtwitz and Gassmann (2016). This model is also prevalent in all milestones subsequent to ‘Design freeze’, where subsidiaries with full autonomy for development carry out the activities of structure simulation, definition of developers-suppliers, design of projects, parts and systems, prototype making, testing and approving, defining processes and suppliers, which culminates in pre-series, pilot series and start of production at the various subsidiaries.

Similarly, we can evaluate Zedtwitz and Gassmann’s (2016) five configurations by considering the main R&D macro-activities in the automotive industry: platform development, derivatives development, tropicalization, and location. As Volkswagen concentrates in headquarters all R&D for the creation of a new platform, this activity, at the top of the automotive development pyramid, is equivalent to the **Do-alone R&D** model. The derivative development tasks are assigned to the main R&D areas outside headquarters, in a model equivalent to **R&D Hub**. A number of subsidiaries, less relevant to the group, address Tropicalization and Location tasks.

As found in the interviews, we have confirmed the existence of some iconic cases of reverse innovation in the Volkswagen group. These processes took place mainly in subsidiaries that have been operating for a long time in emerging economies, such as Brazil and China.

In 1991, the Santana 2000 was developed for China, based on the second generation of the German Passat, with the help of Brazilian Volkswagen R&D. It started in 1994, and mass production initiated in April 1995; this was the first project that engineers at the Shanghai Volkswagen Automotive joint venture undertook alone. In 2012, the new Santana was also introduced in Wolfsburg, VW's headquarters in Germany, as a small family car for the C segment. Therefore, this vehicle, built in China by Chinese workers and only later introduced in Europe, is a classic example of reverse innovation (Zedtwitz *et al*., 2014).

A similar example occurred with the Brazilian subsidiary, when it launched the Fox in 2003. The Brazilian R&D center developed the subcompact on a European Polo platform. Since then, it has been sold in Brazil and Latin America, being later adapted to the European market and sold there between 2005 and 2011. It was never produced in Europe, and Brazil exported it as FBU (Full Built Unit) and sold it there, mainly in Germany. As with Santana, Fox is a spillover type innovation from an emerging market (Zedtwitz *et al*., 2014).

More recently, another development of the Brazilian subsidiary is a new icon of reverse innovation. The Nivus coupé car was fully developed in Brazil, also on the European Polo platform, and launched in the country and in South America. As happened with the Fox, it will be sold later in Europe, and manufactured there. The Brazilian R&D center is conducting the whole adaptation of the Brazilian car to the European market.

Thus, the three cars (Santana-China, Fox-Brazil, and Nivus-Brazil) follow the spillover from emerging markets -, if we consider the types of reverse innovation defined by Zedtwitz *et al*. (2014). In the case of Volkswagen, as the platform already exists in Europe, the concept is usually determined in an advanced country, with development and first market in an emerging country; the second target market is an advanced market, in this case Europe.

Very soon, VW's Mexican subsidiary will also show an example of reverse innovation - a vehicle with development and production in Mexico for later commercialization in the American market. The country’s R&D center is carrying out the main development, with the participation of Brazilian R&D. When the vehicle is launched in the United States, it will become another example of reverse innovation.

This sets a trend for the coming years. As found in the interviews, through the process of decentralizing R&D activities from headquarters to subsidiaries, strengthening regional R&D, and increasing subsidiaries' autonomy, we will probably see more and more examples of reverse innovation at the Volkswagen group in the future.
Using the knowledge flow model in R&D networks (Awate *et al.*, 2015), which shows the relationship between headquarters and subsidiaries (Figure 4), we found that, in the case of Volkswagen, the head office in Wolfsburg is both the oldest unit and the one with the highest level of knowledge throughout the chain.

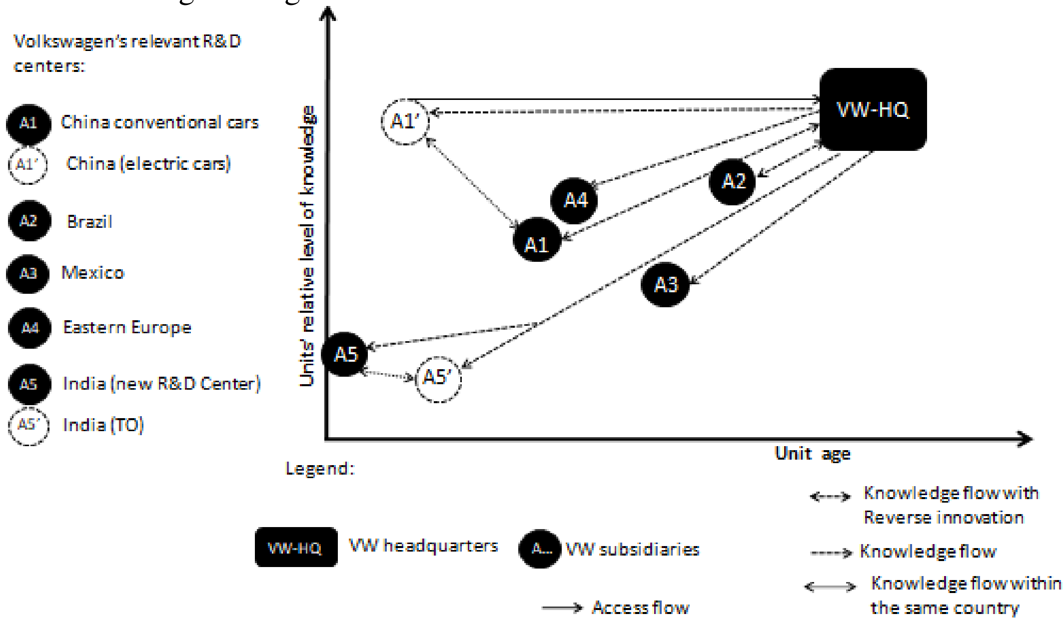

Figure 4- Knowledge flow in the R&D network, to and from Volkswagen
Source: based on Awate *et al.* (2015), interviews, and secondary data.

From the high level of knowledge created within headquarters over the years, we observed that most of the knowledge flows are of the conventional type, that is, knowledge departs from there towards subsidiaries, and is the traditional source for a less developed subsidiary. Over time, subsidiaries tend to evolve and become closer to headquarters, more competent and autonomous, such as China and Brazil subsidiaries. In these two subsidiaries, as they have already undergone reverse innovation processes, the knowledge flow goes in both directions. Headquarters conveys the expertise in new and high technologies, platform definition and concept, while subsidiaries contribute with innovations in less complex (and consequently, cheaper) systems, alternative innovative solutions, or different design. This is because R&D subsidiaries can make specific and global contributions to the MNE, in addition to their local markets, setting up external network links with other companies and institutions.
We highlight the role of the Chinese subsidiary, specifically for electric cars, shown in Figure 4 as A1'. This unit, relatively younger than the conventional car unit, has an expertise in developing electric cars equivalent to that of headquarters. This knowledge in electric vehicles has come, in part, from the Chinese train industry, and from the country's imminent need to reduce greenhouse gas emissions, which has led several independent companies to invest heavily in electric cars' technology. Hence, we observed the only case of access flow (Awate *et al.*, 2015), which only occurs when headquarters has access to a technology similar or more advanced than its own - developed by the Chinese subsidiary for electric cars.
Another relevant issue is the recent establishment of a new R&D center in India, to replace the existing Technical Office. According to the interviewee, there was a massive investment in R&D facilities and hiring of qualified professionals, in addition to the active participation of those from headquarters. The level of technology and expertise is already higher than in the

previous R&D center (of the TO type), with a trend of fast evolution in the next years, which should mean an increase of autonomy and responsibilities.
Knowledge transmission among the various subsidiaries is a reality. The new car that Mexico is currently developing for sale in the United States receives support from Brazilian R&D, as well as its development base is a Chinese vehicle.

Limitations and Future Research
The topic of R&D internationalization and location, especially in the automotive sector, has strategic importance for MNEs, as it fosters technological innovation, scientific dissemination, and the creation of new products, which can make the difference between companies' success and failure. Therefore, both R&D activities and R&D internationalization processes are confidential, so that achieving primary data for result analysis is very difficult. Thus, a single case study that compared different subsidiaries within the same economic conglomerate was the most appropriate method.
An aspect that drew attention in this study was that, when Volkswagen has an important and operational R&D center in a given country, the brand's penetration power is also quite significant, such as in China and Brazil. Instead, when the company has plants for local production, but no relevant R&D center, brand penetration is very modest, as in India and the United States; despite being high-volume markets, Volkswagen's market share is very small. Therefore, a study that suggests hypotheses and tests the correlation between strong R&D centers and the penetration of a certain brand in those countries may contribute to a better understanding of distinct possibilities for the internationalization of R&D activities and their results for the organization, thus collaborating for new R&D location strategies.
As we noted throughout this study, subsidiaries play an important role in developing new products, but research activities are concentrated at headquarters, and they happen in subsidiaries just to meet a specific need. Future studies could assess the sectors or companies that operate more frequently with dispersed research and compare the results with those of the Auto Industry, in order to find out how to stimulate research activities in R&D centers dispersed among subsidiaries, thus giving them greater autonomy.

REFERENCES

ARIFFIN, N.; FIGUEIREDO, P. **Internacionalização de competências tecnológicas**, Rio de Janeiro: Editora FGV, 2003.
ASAKAWA, K. **Organizational Tension in international R&D management: The case of Japanese firms.** New York: Research Policy, v.30, p.735-753, 2001.
ATHREYE, S.; TUNCAY-CELIKEL, A.; UJJUAL, V. Internationalisation of R&D into Emerging Markets: Fiat's R&D in Brazil, Turkey and India. **Long Range Planning.** London, v.47, p.100-114, 2014.
AWATE.S; LARSEN, M.; MUDAMBI, R. EMNE catch-up strategies in the wind turbine industry: Is there a trade-off between output and innovation capabilities? **Global Strategy Journal**. London, v.2, n.3, p.205–223, 2012.
AWATE.S; LARSEN, M.; MUDAMBI, R. Accessing vs sourcing knowledge: A comparative study of R&D internationalization between emerging and advanced economy forms. **Journal of international Business Studies**. Dallas, v.46, p.63-86,2015.
BELL, M.; PAVITT, K. Technological accumulation and industrial growth: Contrasts between developed and developing countries. **Industrial and Corporate Change**. Oxford, v.2, n.2, p.157–210, 1993
BRUSONI, S.; PRENCIPE, A.; PAVITT, K. Knowledge specialization, organizational coupling, and the boundaries of the firm: Why do firms know more than they make? **Administrative Science Quarterly**, New York, v.46, n.4, p.597–621, 2001.
CANTWELL, J.; MUDAMBI, R. MNE Competence-creating subsidiary mandates. **Strategic Management Journal**. New Jersey,v.26, p.1109-1128, 2005.
CANTWELL, J.; ZHANG, Y. Why is R&D internationalization in Japanese firms so low? A path-dependent explanation.: **Asian Business & Management**. Henderson, v.5, p.249-268, 2006.

CHINA GLOBAL TELEVISION NETWORK - CGTN. **BizTalk:** Volkswagen Group CEO Herbert Diess on the auto industry's future. Beijing: China Global Television Network, 2020. Available in: <https://www.youtube.com/watch?v=yr-069k7gGI>. Access:10 fev.2020.

COSTA,S; BORINI, F.; AMATUCCI,M. Global innovation in foreign subsidiaries located in emerging markets. **Revista de Administração Contemporânea**. São Paulo, v.17, n.4, p. 459-478, 2013

DEMIRBAG, M.; GLAISTER, K. Factors determining offshore location choice for R&D projects: a comparative Study of Developed and emerging regions. **Journal of management studies**. Sheffield, v.47, n.8, p.1534-1560, 2010.

EINSENHARDT, K. Building Theories from Case Study Research. **The Academy of Management Review**. Califórnia, v.14, n.4, p.532-550, 1989.

FILATOTCHEV, I.; PIESSE, J. R&D, internationalization and growth of newly listed firms: European evidence. **Journal of International Business Studies**. Londres, v.40, p.1260–1276, 2009.

FISCH, J. H. Optimal dispersion of R&D activities in Multinational corporations with a genetic algorithm. **Research Policy**. New York, v.32, p.1381-1396, 2003.

GASSMANN, O.; HAN, Z. Motivations and Barriers of foreign R&D activities in China. **R&D Management** New Jersey, v.34, n.4, p.423-437, 2004.

GASSMANN, O.; von ZETTDWITZ, M. New concepts and trends in international R&D organization. **Research Policy.** New York, v.28, p.231-250, 1999.

GLORAD. **R&D Locations Database**. Kaunas: Center of Global R&D and innovation, 2020. Available in: <http://www.glorad.org/#/>. Access: 07 Jan.2020.

GOVINDARAJAN, V.; TRIMBLE, C. **Reverse Innovation:** Create far from home, win everywhere. Harvard Business Review Press. Boston, 2012.

HERSTENSTEIN, P.; WILLIAMSON, P. The role of suppliers in enabling deferring innovation strategies of competing multinationals from emerging and advanced economies: German and Chinese automotive firms compared. **Technovation.** Cambridge: v.70-71, p.46-58, 2018

HESSLER, U. **Tesla market cap surges past Volkswagen to $100billion**. Berlin: DW, 2020. Available in: <https://www.dw.com/en/tesla-market-cap-surges-past-volkswagen-to-100-billion/a-52119603>. Access: 04 Feb.2020.

HSU, C.W; LIEN, Y; CHEN, H. R&D Internationalization and Innovation Performance. **International Business Review**. New York, v.24, p.187-195, 2014.

International Organization of Motor Vehicle Manufacturers [**OICA**] (2018). **Statistics.** Available in: <http://www.oica.net/category/production-statistics/2017-statistics/>. Access: 18 Oct.2019.

KAFOUROS, M et al. The role of internationalization in explaining innovation performance. **Technovation**. New York: v.28, p.63-74, 2008.

LORENZEN, M. Knowledge and geography. **Industry and Innovation**. Copenhagen, v.12, n.4, p.399–407, 2005.

MUDAMBI, R. Location, control and innovation in knowledge intensive industries. **Journal of Economic Geography**. Philadelphia, v.8, p. 699–72, 2008.

MUDAMBI, R.; NAVARRA, P**.** Is knowledge power? Knowledge flows, subsidiary power and rent-seeking within MNCs. **Journal of International Business Studies**. Philadelphia, v.35, p.385–406, 2004.

Pogrebnyakov, N.; Kristensen, J. D. Building innovation subsidiaries in emerging markets: The experience of Novo Nordisk. **Research-Technology Management***, 54*(4), 30-3. _2011.

Qi, M., Wuang, Y.; Zhang, M. Y.; Zhu, H. The evolution of R&D capability in multinational corporations in emerging markets: evidence from China **International Journal of Technology Management,***4*(24). 2014.

QUADROS, R.; CONSONI, F. Innovation capabilities in the Brazilian automobile industry: a study of vehicle assemblers' technological strategies and policy recommendations**. International Journal of Technological Learning, Innovation and Development**, São Paulo, v.2, n.1/2, 2009.

STATISTA. **Brand reports**. Hamburg. 2019. Available in: <https://www.statista.com/ studies-and-reports/#panelIndustryReports>. Access: 12 Sep.2019.

VOLKSWAGEN. **E-mobility:** moving from a niche product to the mainstream. Frankfurt: IAA. p.2-6, 2019.

VOLKSWAGEN. **Brands & Models**. Wolfsburg: Volkswagen AG, 2020. Available in: <https://www.volkswagenag.com/en/brands-and-models/volkswagen. html> . Access: 14 Mar.2020.

YIN, R. **Qualitative Research from start to Finish.** New York: Library of Congress, 2003.

ZANDER, I. et al. Born global and international business: Evolution of a field of research. **Journal of International Business Studies**. Londres, v.46, n.1, p. 27–35, 2015.

ZEDTWITZ, M. et al. **A Typology of Reverse Innovation.** Kaunas: J. Prod. Innovation Management, 2014.

ZEDTWITZ, M.; GASSMANN, O. Market versus Technology drive in R&D internationalization: four different patterns of managing research and development. **Research Policy**. Kaunas, v.31, p.569-588, 2002.

ZEDTWITZ, M.; GASSMANN, O. Global Corporate R&D to and from Emerging Economies. **The global innovation index.** Kaunas, v. 9, p.125-131, 2016.