

DYNAMIC CAPABILITIES IN AUTOMOTIVE POLLUTANTS REDUCTION TECHNOLOGIES: CASE STUDY

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ABSTRACT

Purpose: The aim of this paper is to analyze the dynamic capabilities related to the generation of pollutant reduction techniques according with Teece's proposition. In order to do so, we developed a case study in a Brazilian automaker.

Originality/gap/relevance/implications: This paper discusses empirically aspects of creation of dynamic capabilities and innovations from its foundations. The originality of the study resides in a clearer understanding inside an organization the conception of dynamic capabilities and innovations through time.

Key methodological aspects: In this paper, an automaker was studied, focusing on interviewers' interpretations concerning on the creation of reduction of pollutants technologies. The data collected were qualitative and they were analyzed through the technique of content analysis.

Summary of key results: As main results, we observed that Integration and development capabilities were found and they were characterized as dynamic capabilities in the sense that, they are all based in the automaker's adaptation to its external environment. The path dependence of the automaker was also observed, through all the innovations that were created during the automaker's history towards more efficient and less pollutant vehicles.

Key considerations/conclusions: Summarizing, the automaker seeks to 'perceive' its dynamic capabilities from market's actions, since the organization has an historical path and also its R&D capabilities. So on the seizing phase of the Dynamic Capabilities, the organization seeks to 'create value' to its customers.

KEYWORDS

Dynamic Capabilities. Innovations. Collaboration. Pollutant Emissions. Automotive Industry.

1. INTRODUCTION

The dynamic capabilities approach comes from the realization that the accumulation of technological assets by the organization is not a sufficient condition to ensure competitive advantages. In this context, it would require an ability to coordinate internal and external competences, in order to adapt the organization to a rapidly changing environment (Pelaez, Melo, Hofmann, & Aquino, 2008). One of the main results of dynamic capabilities is the creation, renewal or integration of resources, assets, capabilities, competencies and routines, enabling organizations to keep up with changes in the competitive environment (Tondolo, Tondolo, Puffal, & Bittencourt, 2015). Thus, dynamic capabilities consider the external environment of the organization as a central aspect, and are constructed instead of acquired, based on the existing processes, routines and organizational resources over time, representing the integration, construction and systematic reconfiguration of the organizational competences according to market threats and opportunities (Leite, 2013). Dynamic capabilities also contribute to the impact on operational capabilities, integrating resources and processes into the environment (Teece, Pisano, & Shuen, 1997). In summary, dynamic capabilities are high-level activities that enable a firm to target the production of goods and services that already have or may have high market demand (Teece & Leih, 2016).

The automotive industry, of significant importance in the Brazilian and worldwide scenario, undergoes a transition and a period of uncertainties in which there are questions about the use of fossil fuels and the internal combustion engine as the dominant technology standard. In fact, the automotive industry is facing important challenges, mainly associated with an irreversible tendency to increase efficiency, reduce fuel consumption and seek new solutions to meet this new market. It can be argued that the traditionally widespread transportation solution model (a self-propelled vehicle powered by petroleum-based fuels), which has lasted for a century, is depleted (Casotti & Goldenstein, 2008; Sierzchula, Bakker, Maat, & Van Wee, 2012). However, in recent years, and contrary to the future trends mentioned above, the profile of vehicles sold in Brazil has converged to larger and less efficient models, and among Brazilian cars, there is a trend of higher fuel consumption (Bastin, Szklo, & Rosa, 2010).

In this sense, despite the current scenario of production and market, there is a need to encourage a search for renewal and transformation in the *modus operandi* of the automobile industry, in order to respond to the challenges and changes in the patterns of production, consumption and legal require-



ments inherent to the sector. Taken as a possible option, electric propulsion should gradually replace internal combustion engines and different technological standards will coexist in the future, being the hybrid vehicle and the purely electric vehicle the main alternatives. For Brazil, a viable alternative would be the development of ethanol hybrid electric vehicles, exploring the existing local technology and the knowledge generated in the production of this renewable fuel (Alves, 2011; Mesquita, Borges, Sugano, & Santos, 2013). Considering the scenario of exploration of renewable fuel sources and the possible entry of electric vehicles into the market, local industry needs to follow the movement initiated at a global level if it intends to maintain its relevance (Castro & Ferreira, 2010). A fact that corroborates the importance of industry in Brazil, and is also a justification for the present study, is the growth of exports and the increase of local activities of research and development (R&D) and the capabilities of organizations in the sector (Quadros & Consoni, 2009).

Because of the wide variety of technologies in automotive industry, in this study, we intend to focus on those related to the reduction of pollutants. According to Christensen (2011), the automotive industry has been under pressure to reduce the environmental impact of cars, by manufacturing 'cleaner' and more fuel-efficient models. Since the early 1970s, Brazil has played a leading role in the development of renewable fuels for different purposes, ranging from automobiles to the generation of electricity for airplanes (Damiani, 2008).

Thus, this study proposes to analyze the dynamic capabilities in the automotive industry associated to the generation of technologies related to the reduction of pollutants, based on a case study carried out in an automaker plant in the country and structured through interviews with managers and directors allied to the areas of engineering and innovation, whose reports were analyzed using the technique of content analysis. So, the objective of this article is to identify the main organizational capabilities in the automotive sector, from the point of view of a focal organization, directing the study to the technologies of pollutant emission reduction. For the purpose of analysis, this paper will discuss the generation of dynamic capabilities in an automaker based on Teece's ideas (Teece, Pisano, & Shuen, 1997; Teece, 2007, Teece & Leih, 2016).

The text is structured as follows: first, the main concepts of the dynamic capabilities approach and the context of the pollutant emission reduction technologies are presented; second, the methodological procedures of the research are presented, such as the aspects about qualitative research, case study, the technique of data collection through in-depth interviews, and the



technique of content analysis; third, the results of the empirical research are presented and discussed, with a focus on the elements of sensing, seizing, and management of dynamic capabilities. Finally, the final considerations of the study are presented, pointing out some conclusions about the addressed problem, as well as some limitations of the study and suggestion of future research involving the topics addressed in the article.

2. DYNAMIC CAPABILITIES AND POLLUTANT EMISSION REDUCTION TECHNOLOGIES

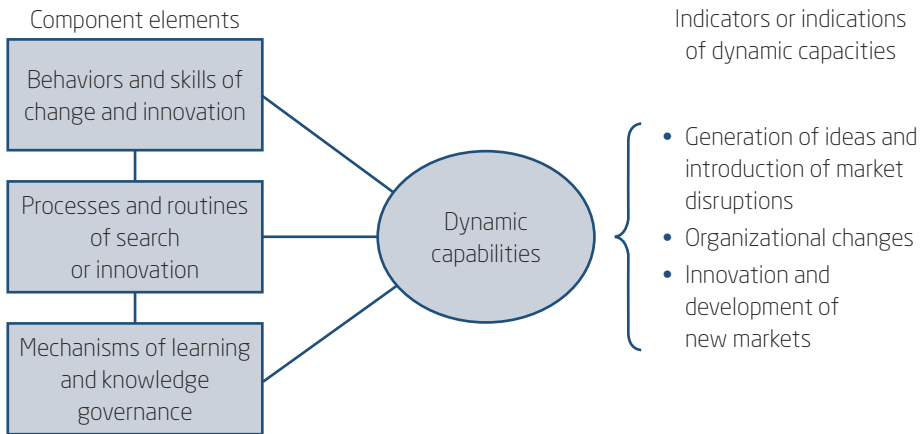
The dynamic capabilities approach presents some specific aspects of definition, which constitute an important part of the existing body of knowledge about the subject. Strong dynamic capabilities are the means to create the organizational agility necessary to deal with the increasing uncertainty generated by innovation and competition (Teece, Peteraf, & Leih, 2016). For Winter (2003), there is a broad consensus in the literature regarding the understanding that dynamic capabilities contrast with so-called ordinary (or operational) capabilities, because the former would be concerned with the change. In this way, ordinary resources and competencies differ from dynamic capabilities. According to Teece & Leih (2016), ordinary capabilities involve skills for the proper execution of functions, administrative and governance tasks. Dynamic capabilities, however, create and shape business environments. As an example of the concept application, Protogerou, Caloghirou and Lioukas (2012) carried out a quantitative study with 271 companies from different sectors, concluding that the dynamic capabilities of coordination, learning and competitive response positively and indirectly impacted the operational capabilities of technology and marketing of the company. For the authors, the dynamic capabilities support the mentioned operational capabilities, impacting the profitability and the market share of the companies.

For Parmigiani & Howard-Grenville (2011), the capability perspective, whether in a stable or changing environment, emphasizes the motivation and results of routines with a focus on knowledge transfer within and between organizations. The challenge of dynamic capabilities, both in theoretical and empirical terms, is to identify the capabilities required by companies in different contexts, showing how they should be allocated and modified, especially in organizations that are already established in the market and are strongly subject to environmental discontinuities (Birkinshaw, Zimmermann, & Raisch, 2016).

Meireles and Camargo (2014), based on a review of available literature about the subject, propose a conceptual and operational approach to dynamic capabilities based on three fundamental components: skills, routines and processes. For the authors, the dynamic capabilities would be the result of behaviors and skills of change and innovation, associated to the processes and routines supported by mechanisms of learning and knowledge governance. Finally, the authors still point out indicators of characterization of dynamic capabilities, involving elements such as the generation of ideas and introduction of market ruptures, organizational changes and innovations, and the development of new markets. All these elements are arranged in figure 1:

(Figure 1)

CONCEPTUAL AND OPERATIONAL APPROACH OF DYNAMIC CAPABILITIES



Source: Meirelles and Camargo (2014, p. 58).

At the same time, Regnér (2008) establishes a set of characteristics about the dynamic capabilities as shown below (Figure 2):

(Figure 2)

CHARACTERISTICS OF DYNAMIC CAPABILITIES

Dynamic Capabilities	Characteristics
General unit of analysis	Organization's level, development of complex and initial routines
Managerial focus	Managerial behavior in organizational processes
Final result	Organizational performance

(continue)

(Figure 2 (Conclusion))

CHARACTERISTICS OF DYNAMIC CAPABILITIES

Dynamic Capabilities	Characteristics
Contextual importance	Historical and localized (economic context)
Strategic focus	Situational strategy
Basic mechanism	Coordination and combination of routines and systems at the organizational level
Context	Position of assets (technological, financial, etc)
Control	Environmental selection mechanisms
Focal unit	Value-generating capabilities

Source: Regnér (2008).

In the field of organizational theory, Dosi, Faillo & Marengo (2008) consider the organizational routines within a more operational bias, regardless of size and capacity issues as broader questions in the line of learning and knowledge. In a bibliometric review study with articles published in the period from 1990 to 2007, using the database Web of Science, Di Stefano, Peteraf & Verona (2010) point out that the most relevant factor in terms of the approach to dynamic capabilities are their concepts and applications, since it is a relatively recent theme, given the publication of the seminal article by Teece in 1997 (Teece, Pisano, & Shuen, 1997).

The literature on dynamic capabilities has been concerned with discussions about its definitions and the properties that allow organizations to be adaptive entities. Research on this theme must be based on a central problem of organizations: how to identify and select capabilities that lead to competitive advantage (Pisano, 2016). In addition, capabilities can also be understood as being adaptive and organizational ‘path-dependent’ (Teece, Pisano, & Shuen, 1997). Teece (2000) states that the capabilities must be dynamically managed by alliances, with the definition of organizational boundaries that enable the exchange of competences. For Balestro, Antunes Jr., Lopes & Pellegrin (2004), the work of Teece, Pisano, & Shuen (1997) defined three elements as generators of dynamic capabilities: 1. organizational processes related to the capacity for integration and or effective and efficient coordination of internal and external resources of the organization, its ability to learn and reconfigure assets based on the constant examination of the environment; 2. positions, which involves the possession of specific assets (technological, financial, reputational, structural etc.), having important implications for the

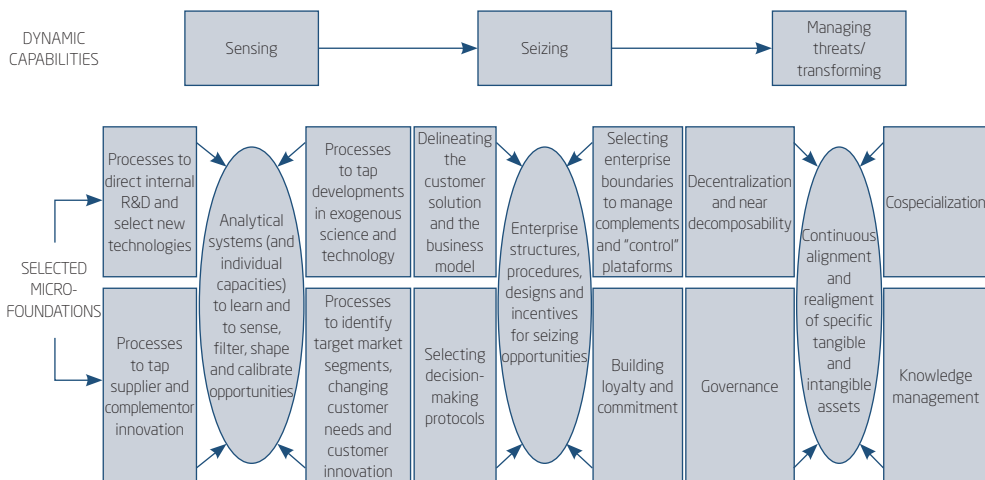
level and management of innovation; 3. trajectories in which a firm’s previous investments and its repertoire of routines restrict and condition its alternatives and its future behavior (Balestro *et al.*, 2004; Teece, Pisano, & Shuen, 1997). Thus, organizations do not have a ‘broad menu’ of alternatives, but rather a restricted field of options based on the economic aptitudes of firms that can be ‘activated’ by the environment (Mesquita, Figueira, & Sugano, 2011; Nelson & Winter, 2006). Therefore, fast and dynamic environments favor the opening of organizations, creating processes that convert individual capabilities into collective knowledge (Felin & Powell, 2016).

Dynamic capabilities are therefore considered as strategic routines that enable managers to capture resources, which can be integrated, modified and recombined to generate new value-creating strategies (Chen & Long, 2009). The ability to perceive, organize, and effectively embrace valuable strategic options is at the heart of an organization’s dynamic capabilities (Dong, Garbuio, & Lovallo, 2016).

Barreto (2010) states that the dynamic capability represents the potential that the company has to systematically solve the problems, being characterized as follows: the propensity to perceive environmental opportunities and threats, the ability to make market-oriented decisions in the appropriate time horizon and the capacity to change its resource base. Teece (2007) identifies that the fundamentals of dynamic capabilities span three stages (Figure 3): sensing; seizing and management and transformation.

(Figure 3)

FUNDAMENTALS OF DYNAMIC CAPABILITIES



Source: Teece (2007, p. 1342).

The propositions of Teece (2007) will be used in this article to identify the presence of some elements of the dynamic capabilities in the studied automaker. Among the innovations described in the present study, we highlight the use of technologies for energy efficiency and reduction of pollutant emissions. This context requires organizations, and more specifically those within the automotive industry, to develop new technological and organizational capabilities, with an increasingly intensive use of knowledge (Faria, 2012).

In this sense, one of the aspects that currently has the industry's attention is the issue of reducing carbon or CO₂ emissions. According to Lee (2012), without a radical technological development in engines more independent of fossil fuel, the auto industry must face an increasing pressure from consumers, regulation entities and the society in general. The Americans and Japanese have explored the hybrid solution, associating one electric engine to another with gasoline combustion. In Brazil, flexible or bi-fuel (fueled with ethanol or gasoline) automobiles dominate almost the entire Brazilian production (Luz, Oliveira, Santos, & Quintairo, 2012; Mesquita, Borges, Santos, & Sugano, 2013). Van der Vooren, Alkemade, and Hekkert (2013) showed that in the Dutch automobile industry, automakers have promoted a significant reduction in CO₂ emissions between 2001 and 2010 through the adoption of automotive energy efficiency programs. As a result, the authors point out that the automakers with the largest product portfolio could offer to consumers broader options, among cars that emit more or less CO₂, while automakers with smaller portfolio opted to offer to consumers models emitting less CO₂ as their main strategy.

In this view, the strategic behavior of organizations in the automotive sector in relation to aspects associated to the generation and development of technologies to reduce pollutant emissions and for energy efficiency is important for their performance in the market. By developing dynamic capabilities in these areas, these companies not only respond to institutional pressures, whether from the State, regulatory agents or the consumer market, but also position themselves in the market in a competitive manner, setting new production, marketing and innovation parameters in the industry, a fact that demands greater understanding by the academy and that provides a support for the accomplishment of this study.

3. METHODOLOGICAL PROCEDURES

The present paper, which is exploratory and qualitative, was based on the analysis delimitation of Carlsson, Jacobsson, Holmén, and Rickne



(2002), defining, in a sector context, the most appropriate levels to reach the proposed general objective. The focus was the automotive sector, with the accomplishment of a case study in an organization in which the dynamics of innovation became present, as well as other areas, in the development of technologies linked to gains in energy efficiency and reduction of pollutants emission.

The research strategy, characterized as a case study, is defined as an empirical research that investigates a contemporary phenomenon within its real-life context; usually, the case study is the preferred strategy when seeking to answer questions of the type 'how' and 'why', by focusing on a contemporary phenomenon within a real-life context (Yin, 2001), and is appropriate for research in the field of strategy and organizational innovation (Borges, Alvim Jr., Mesquita, & Enoque, 2014).

The chosen organization was a multinational automobile manufacturer located in Brazil. The organizational unit under review in this article has a production capacity of more than 800 thousand cars/year, and in 2012 this production was higher than 811 thousand cars/year. The organization has around 30 thousand direct and indirect employees.

The data collection was carried out through the technique of in-depth interviews. Eleven interviews were conducted with members of the organization's innovation area from April to October, 2013, lasting approximately one hour, conducted by telephone and Internet. These interviews were properly guided through a semi-structured script, which covered topics dealing with organizational capabilities and their relationships with the external environment. The empirical material consisting of the interview audio was recorded and full transcribed later in text editor. It should be emphasized, first, that the data collected were treated in a confidential way, to guarantee the anonymity of the interviewees and the studied organization. Finally, it is also emphasized that the interview data will be presented in the results in order to exalt the most important and illustrative narratives for the analytical categories, so that not all the elements present in the interviews will necessarily be part of the analysis.

For the analysis of the interviews, the content analysis method was used. For Bardin (1979), content analysis represents techniques of communication analysis that, by describing the content of the messages, allow the inference of knowledge regarding the conditions of production/reception of such messages. Content analysis is considered a technique for data processing that aims to identify what is being said regarding a specific topic. The main characteristics of this method are: can be used both for exploratory



and verification purposes; requires exhaustive, mutually exclusive, objective and relevant categories and generates a large amount of data (Vergara, 2006). Finally, it should be emphasized that the content analysis focused on thematic or categorical analysis, which works by dividing the text into units (sentences, paragraphs). The choice was mainly justified by the easiness of its application in direct discourses, favoring the understanding of texts (Bardin, 1979). In the case of this paper, the categories identified in the data were inspired and articulated in association with the theoretical perspectives of dynamic capabilities exposed by Teece (2007), involving the sensing, seizing and management of dynamic capabilities, which are also part of the objectives of the present study.

4. DYNAMIC CAPABILITIES: AN APPLICATION IN TECHNOLOGIES RELATED TO THE REDUCTION OF POLLUTANTS

In this section, the results of the empirical research will be presented and discussed, with the objective of identifying the main organizational capabilities in the automotive sector, from the point of view of a focal organization, directing the study to the pollutant emission reduction technologies. In order to do so, it will be explored three different perspectives associated to the dynamic capabilities approach proposed by Teece (2007), involving the phases of sensing, seizing and management of dynamic capabilities.

4.1. The phase of sensing the dynamic capabilities

Dynamic capabilities can be identified from the trajectory of organizations in a historical perspective, since its foundation, as a characteristic of accumulated knowledge dependence (Teece, Pisano, & Shuen, 1997). In the case of the studied automaker, the dynamic capabilities in issues such as the reduction of pollutant emission emerge from its performance in the Brazilian market, adapting to consumption variables:

The company was already born with the environmental concern, of preserving resources: water, atmospheric air, minerals, etc. So, that's in the company's DNA, it's very deep in the company culture (Interviewee 3).



The [automaker] started in Brazil with small models, as opposed to several competitors who arrived with medium and large models, and are now going to the small, that is, environmentally friendlier ones. And it remains. Even though the range of production has increased, the focus on energy sufficiency has always been decisive (Interviewee 3).

Teece (2007) identifies that the fundamentals of dynamic capabilities span three stages: sensing; seizing and transformation. The stage of sensing of capabilities in emission reduction is present in the automaker in the following elements: adequacy of suppliers; identification of market segments and consumer requirements; and the capacity of individuals to create organizational capabilities in the analytical system:

The basis for everything is technical knowledge. It is the engineers, the technical professionals who will work together and will materialize the product or service. The engineering area, the laboratory areas, play a key role, a central role in the company's competitive capability (Interviewee 3).

The R&D process in the automaker, in general, is also present and can be considered as the basis for the phase of sensing of dynamic capabilities. However, in the studied case, this department is considered as an external information element. In other words, in the analyzed case, it is verified that a great part of the R&D activities are carried out in the main office, outside Brazil. Costa, Porto and Gonçalves (2013) argue that multinational automakers centralize R&D and innovation management activities in their headquarters, but take advantage of the global network of knowledge they have, facts that can be observed in the studied case, as follows:

As a rule, here in Brazil is much manufacturing. You have some engineering resident here and the rest is manufacturing. The development, the knowledge itself ends up being generated outside. Now, there is a lot of technology exchange, yes. (Interviewee 9).

The R&D issue at the automaker regarding emissions reduction points to the absence of ambidexterity of the organization, with a predominance of exploitation activities to the detriment of exploration initiatives. This concept was first expounded by March (1991) and shows that organizations are involved in a simultaneous action between activities called exploration



(search for new knowledge and innovations) and exploitation (work with existing knowledge, refinement). For the author, the balance between these two activities guarantees the survival of the organization in the long term. Thus, when the organization promotes exploitation activities, there is less effort in radical innovations and, in the medium and long term, it can be an element of influence in the obsolescence of the existing knowledge in the organization. In the practice of exploitation, explicit knowledge is more present and there is an idea of continuity, routines, patterns, repetition (Popadiuk, 2010). In this sense, in the case of the studied automaker, it was verified the option of incremental innovations (exploitation) for emissions reduction (such as fuel economy) in detriment of more radical innovations (exploration) such as hybrid cars.

The knowledge we have, it is not research oriented, It is development oriented. So, when we talk about R&D (Research and Development), our D is much stronger than our R. That is, we are a company that has a large area in research development of products. We have 1,000, almost 1,500 people working in this area of product development, consolidated in laboratories, project areas, project, we do it all, calm, no problem at all ... I'm not saying that we do not develop technology inside the company, but it is not the rule, it is an exception (Interviewee 9).

4.2. The phase of seizing the dynamic capabilities

In the context of seizing capabilities, Teece (2007) points out that the organization must establish: solutions for the consumer and their business model; decision-making protocols; commitment and efficient means of communication and dissemination of values; and organizational boundaries for complementary assets management and the control of platforms, creating an organizational structure that facilitates the seizing of opportunities.

In the capabilities approach consistent with the vision adopted in this article, the business model is related to the creation of competencies for the value-generation in organizations. Internally, value creation tends to the dynamically optimization of processes (Joia & Ferreira, 2005). In this sense, it was observed that the automaker assumes that, from its historically developed capability, the reduction of fuel consumption, not the reduction of emissions, is a mechanism for creating value for consumers:

The focus is the reduction of fuel consumption. The Brazilian customer does not pay more to have an ecological car. Arriving at the store and offering a normal car and an ecological car that costs R\$1,000 more, they do not buy, because they do not see value in that, does not have that responsibility to take care of the environment. Now, if you say: 'this car is more economical, you save R\$5,000 when you ride it', then they buy it (Interviewee 8).

What I think that is nowadays (...) you do not sell car anymore with that (performance), with that appeal. Now it's a 16-valve engine, this and that. The customer no longer buys the engine, he buys if it is a good car, an economical car, if it is a car with interesting drivability, he is no longer concerned with the technology itself, he is more concerned with the benefit that technology gives him (Interviewee 9).

Regarding the interaction aspects and organizational boundaries to control the platforms, it is verified that the automaker (focal organization) seeks to establish partnerships with suppliers to generate emission reduction technologies. From the structural point of view, it should be noted the importance of focal organizations that establish links with tiers, both the upstream (with suppliers) and downstream (with consumers), through member and non-member organizations of the chain (Lambert & Cooper, 2000; Omta & Hoenen, 2012).

This way, exchanges of knowledge and competences between organizations are established, in which each entity defines its share of knowledge. An example of this exchange is the launch of the first bi-fuel model in Brazil in 2003, which represented the success of the automobile industry in the accumulation of knowledge among automakers and automotive suppliers (Mesquita, Borges, Santos, & Sugano, 2013). An important factor is that technological innovation sometimes forces the search for alternatives that are not always available in-house, that is, internally (Pisani, Consoni, & Bernardes, 2013).

4.3. The phase of management and adaptation of dynamic capabilities

In the scope of the last perspective of capabilities exposed by Teece (2007), it is highlighted in the results the aspects of governance and co-specialization and knowledge management, also related to the relation automaker/supplier. From this point of view, although this relationship is not

the analysis focus of the article, it is important to discuss the interactions of the supply chain. A supply chain can be defined as the processes that connect organizations from their sources of raw material to the final consumer (Pires & Sacomano Neto, 2008). The supply chain can be seen as a network that encompasses all organizations that participate in the formation and marketing stages of a particular product or service. These organizations can perform different functions in the chain, from the extraction or manufacture of a component, to the provision of logistics or sales services. Depending on its product, an organization can participate in different chains (Scavarda & Hamacker, 2001). In this way, the supply chain management (SCM) enables the structuring of organizations, by means of cooperation and coordination among the various links in the chain. This management aims to reconcile the main stages of the supply chain, from the initial suppliers of raw material to the final customer (Miguel, 2009).

Regarding the aspects of governance and co-specialization, the combination of assets between automaker and supplier must be present. This is a relevant aspect because it relates to the importance of building long-term relationships with suppliers, both for material flow and information, which positively affects the competitive performance of organizations through the exchange of complementary competences (Prajogo & Olhager, 2012). In the Brazilian automobile industry, the links between automakers and first tier suppliers are being strengthened, with the objective of obtaining greater coordination in the execution of activities and better access to external resources, for the generation of innovation, increase of productivity and reinforce the competitive capacity (Martins, Souza Filho & Pereira, 2012).

Rezende, Lima and Versiani (2012) have shown that the existence of knowledge transfer between buyers (automakers) and suppliers, whether technological, market and logistics, of process or relational, depends on the type of the analyzed knowledge. So, the dependence of a supplier on a specific automaker reinforces the strategic alignment in this supply chain (Martins, Souza Filho, & Pereira, 2012). According to Lemos *et al.* (2000), it is necessary to come closer to suppliers for the development of products with a higher technological level in Brazil, the qualification of workers, for institutional incentives and funding. All these elements are described in the following excerpt:

The main competence that we have within the company is integration. We do not develop technology, we integrate technology. So it's innovating the engine technology with suppliers or even with someone who has developed some technology (Interviewee 9).



It can be said that the studied automaker is part of a relational chain in which it seeks the exchange of competences with several suppliers as follows:

The trend now, in my view, is that the development of the supplier comes very close to the customer, who is the automaker. It will already participate in this with its suppliers. And today there is the interest of automakers to participate in the suppliers work (Interviewee 4).

A supply chain currently operates in a dynamic environment under a set of varied constraints, which are both internal to the chain and related to the institutional context in which it is embedded. Thus, organizational actions must follow macro-institutional (political, cultural and economic) and micro-institutional rules (contracts, organizational processes) that directly influence the chain performance and the organizational attitudes (Tang, Cao, & Schvaneveldt, 2008). Among these institutional pressures is the need for organizations to develop technologies or find themselves in sustainable chains.

Pressures on manufacturing organizations to develop 'green' products and technologies have significantly grown over the past decade, prompting them to also pressure their suppliers to find innovative solutions to environmental issues (Vachon, 2007). This is due to the fact that, today, organizations deal with a myriad of environmental challenges such as: global warming, pollution control and a growing demand for environmentally correct products (Doran & Ryan, 2012). Hence, one of the ways organizations respond to these demands is through environmental regulatory mechanisms that are manifested through policies and normative guidelines established by governments in order to direct and stimulate the innovative process of organizations toward less pollutant products, for example (Doran & Ryan, 2012). Regarding the generation of sustainable technologies or practices in the sector, it can be considered that attention to environmental aspects starts with the introduction of new technologies in manufacturing processes, in cooperation with key suppliers (Caniëls, Gehrsitz, & Semeijn, 2013). However, the automakers have been consolidated as innovation locus (Lee, Hounshell, & Rubin, 2010). Barbieux, Zen and Zawislak (2012) report that the company's position in the chain can also define its role in the development of new products (DNP), giving companies more or less autonomy in the DNP. The following excerpt reports the need to increase innovation by suppliers, based on the difficulties faced:

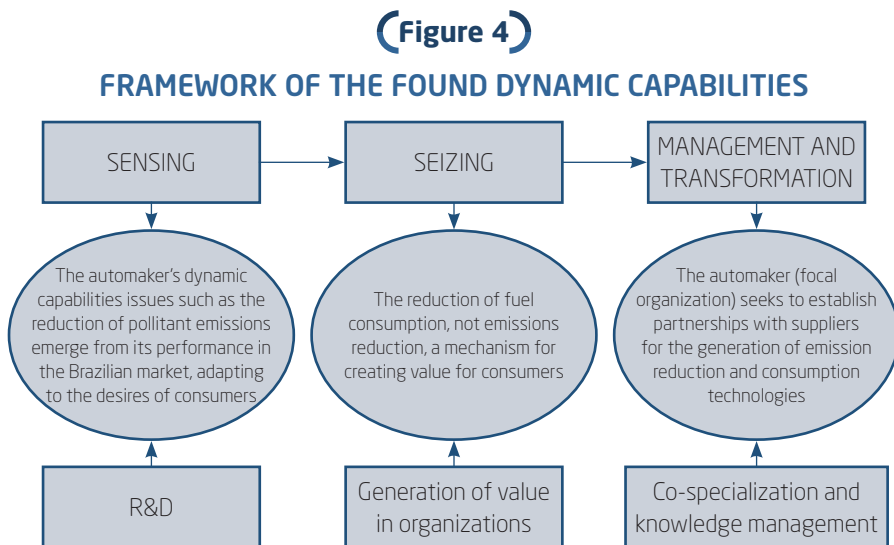


How much do I have to invest? These are questions that are made as if you were at a table negotiating a contract, and it is not... Because innovation is a gamble, we do not know if it will work, if we knew it would work, we would do it ourselves, without anyone's help (Interviewee 8).

Confirming this report, it is noted that, in order to share costs and develop new technologies, automakers increasingly pass on the product development to their first level suppliers, who need to invest more in R&D and knowledge absorption (Faria, 2012).

Therefore, it can be seen that the main capabilities of the automaker are in the aspects of sensing, with the development of technologies and the integration and exchange of knowledge of tangible and intangible assets, technologies and knowledge, respectively (seizing and managing threats). Thus, the main dynamic capabilities of the automaker can be characterized as **development capabilities and knowledge integration capability** (our emphasis). According to Alves, Zen and Padula (2011), the dynamic capabilities can be characterized as construction and integration. In this article, it is observed that the development of emission reduction technologies requires dynamic capabilities of adaption to the market and the consumer.

Seeking to synthesize the results found and based on the conceptual schema of Teece (2007), a framework based on the empirical data was elaborated. With this framework, we sought to overlap figure 3 with the obtained data, as follows:



Source: Elaborated by the authors based on Teece (2007).

In summary, figure 4 demonstrates that the automaker seeks to ‘perceive’ the dynamic capabilities from its actuation in market and due to its historical trajectory and its R&D capabilities. Thus, in the seizing phase, the organization seeks to ‘create value’ for its consumers, acting in the reduction of fuel consumption. Finally, the need for long-term partnerships with supplier organizations to manufacture these technologies is part of the management of these capabilities.

5. FINAL CONSIDERATIONS

The objective of this article was to identify, through the categories presented by Teece (2007) and other authors, the dynamic capabilities associated specifically to initiatives to reduce pollutant emissions in a multinational automaker inserted in the Brazilian automobile industry. For this, the automaker was analyzed as a locus of innovation, focusing on the insights of the interviewees about the generation of pollutant reduction technologies. It was also sought to present a general panorama on the interpretation of the interviewees about the context of these technologies (market, social pressures for adoption, possibilities and technological obstacles to their generation).

The analysis of the results allowed to identify that, within the automaker, the obstacles associated with technologies to reduce the emission of pollutants are more evident in cases of development of technologies for the production of hybrid or electric cars, since both the automaker and the national market do not yet have the proper conditions of absorption of these technologies and their products. Regarding aspects of incremental innovations, especially those related to fuel economy aspects, the interviewees highlighted the automaker’s ability to generate innovations about emissions, mainly with technologies development capabilities. It can be listed the manufacture of new engines, the reduction of the weight of the cars, which contributes to fuel economy and consequent reduction of emissions.

Therefore, in this case study, it is concluded that the generation of capabilities of integration and development of pollutant emission reduction technologies are dynamic capabilities. These two capabilities presuppose the ability of the automaker to adapt to the environment by exploitation actions, either through adaptation to the consumer market, adaptation to the current

legislation in this area, and also through the construction of competences with suppliers and other organizations, as research centers. In summary, the dynamic capabilities of development and integration reflect the need and the search of the automaker for adaptation to market conditions and the creation of new markets, based on research with disruptive innovations in the long term. Finally, another important element is highlighted, which is the trajectory of innovations in emissions, which historically reports the construction of capabilities in the automaker. The found capabilities also confirm themselves as dynamics as, through the reports, is observed the path dependence of the automaker, based on the history of the organization and innovations generated over time, which confirm its trajectory towards more efficient and less pollutant cars.

The findings of this research, concerning the trajectory of capabilities, are consistent with a research agenda pointed out by Pisano (2016). The author believes that the ways in which capabilities are sought by organizations over time must be investigated. Thus, this article theoretically contributes to provide elements for a more detailed and recent investigation on this subject, and generates subsidies for the accomplishment of other studies about processes of generation and development of dynamic capabilities, mainly in the Brazilian automotive industry. In addition, the study contributes to organizational practice, because it highlights a specific reality, which is a good example of the different paths that can be traced in the development of dynamic capabilities in the Brazilian automobile industry, thus serving as the basis for the understanding of its practices and for managers' reflexive thinking about the implications of their actions in the scope of processes of generation and development of technologies and capabilities in this industry.

The main limitation of the study is: the focus on only one organization to study a perspective of innovation and capabilities, which often involves other organizations and the non-use of other materials, as documents, to expand the analysis together with the interviews. As a suggestion for future studies, we suggest a longitudinal study in order to verify the construction of these dynamic capabilities in the long term. We also suggest studies with more than one automaker or between automaker and supplier to confront different visions in the innovative process.

CAPACIDADES DINÂMICAS EM TECNOLOGIAS DE REDUÇÃO DE POLUENTES AUTOMOTIVOS: ESTUDO DE CASO

RESUMO

Objetivo: Analisar, de acordo com as proposições de Teece, as capacidades dinâmicas na indústria automotiva associadas à geração de tecnologias para redução de poluentes, a partir de um estudo de caso realizado junto a uma montadora de automóveis instalada no país.

Originalidade/lacuna/relevância/implicações: Este artigo discute empiricamente os aspectos de geração de capacidades dinâmicas e inovações, verificando sua trajetória a partir de seus fundamentos. A originalidade do estudo reside em compreender, mais claramente, a concepção das capacidades dinâmicas e inovações em uma organização ao longo do tempo.

Principais aspectos metodológicos: Foi estudada uma montadora de automóveis tendo como foco, especificamente, a interpretação dos entrevistados sobre a geração de tecnologias voltadas para a redução de poluentes. Os dados foram analisados qualitativamente por meio da técnica de análise de conteúdo.

Síntese dos principais resultados: Como principais resultados, observou-se que foram encontradas as capacidades de integração e de desenvolvimento, sendo estas caracterizadas como dinâmicas na medida em que as duas pressupõem a capacidade da montadora de adaptação ao ambiente externo. Também se observou a dependência de trajetória da montadora, a partir de inovações geradas historicamente, as quais demonstram a sua orientação à produção de automóveis mais eficientes e menos poluentes.

Principais considerações/conclusões: Em síntese, a montadora procura ‘perceber’ as capacidades dinâmicas a partir de sua atuação no mercado, devido a sua trajetória histórica e a suas capacidades de P&D. Assim, na fase de aproveitamento das capacidades dinâmicas, a organização busca ‘criar valor’ para seus consumidores.

PALAVRAS-CHAVE

Capacidades Dinâmicas. Inovação. Colaboração. Emissão de Poluentes. Indústria Automotiva.

CAPACIDADES DINÁMICAS EN TECNOLOGÍAS REDUCTORAS DE CONTAMINANTES AUTOMOTORAS: ESTUDIO DE CASO

RESUMEN

Objetivo: Este artículo tuvo como objetivo discutir la creación de capacidades dinámicas, basado en las ideas de Teece.

Originalidad/laguna/relevancia/implicaciones: Este artículo discute empíricamente los aspectos de creación de las capacidades dinámicas e innovaciones verificando su trayectoria a partir de sus fundamentos. La originalidad del estudio reside en comprender más claramente en una organización la creación de las capacidades dinámicas e innovaciones a largo del tiempo.

Principales aspectos metodológicos: Así fue analizada una ensambladora de automóviles, haciendo foco en la interpretación de los entrevistados acerca de la creación de tecnologías reductoras de contaminantes. Los datos fueron analizados cualitativamente, por medio de la técnica de análisis de contenido.

Síntesis de los principales resultados: De esa manera, como resultados principales, fueron encontradas las capacidades de integración y de desarrollo, siendo caracterizadas como dinámicas en la medida en que las dos presuponen la capacidad del fabricante de adaptación al ambiente externo. También se notó la dependencia de trayectoria del fabricante, a partir de las innovaciones generadas históricamente que demuestran su orientación a la producción de automóviles más eficientes y menos contaminantes.

Principales consideraciones/conclusiones: En síntesis, la ensambladora busca “percibir” las capacidades dinámicas a partir de su actuación en el mercado, por su trayectoria histórica e sus capacidades de I& D. Así en la fase de aprovechamiento de las capacidades dinámicas, la organización busca “crear valor” para sus consumidores.

PALABRAS CLAVE

Capacidades Dinámicas. Innovación. Colaboración. Emisión de contaminantes. Industria Automotora.

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