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# UNDERSTANDING INNOVATION ADOPTION DIFFERENCES BETWEEN THE US AND BRAZIL: A COMPARATIVE STUDY ON ORIGINAL EQUIPMENT MANUFACTURERS

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## 1. INTRODUCTION

The automotive industry has been facing deep transformations since Henry Ford and Alfred Sloan's creation of the assembly line – from Toyota's lean production (Womack, Jones & Roos, 2007; Wells, 2010), to China achieving worldwide leadership in automotive production (OICA, 2015; OICA, 2017) and to the advent of disruptive technologies like autonomous vehicles, fuel cells and car connectivity (Wallbank, McRae-McKae, Durrell & Hind, 2016).

As it happens on different industries, in the automotive arena the innovation adoption process starts with the framing of a specific set of problems to be solved (Utterback, 1994; Roberts, 2007; Drejer, 2002), proceeding next with the choice of alternatives and their effective implementation (Tornatzky & Fleischer, 1990). Innovation adoption by organizations must be made carefully in a way to ensure that a company's limited resources, including time, will be invested in the creation of profitable and sustainable products. Ideally, it should be influenced by organizational (Nahm, Vonderembse & Koufteros, 2003; Zamutto & O'Connor, 1992; Kitchell, 1995), technological (Chong & Zhou, 2014; Wang, Wang & Yang, 2010) and environmental (Tornatzky & Fleischer, 1990; Damanpour & Schneider, 2006) contexts. For each of these contexts, there is a series of influence factors and they have been thoroughly studied over the years, mostly in the fields of education, electronic commerce, information systems, artificial intelligence, and mobile applications (Hammeed, Counsell & Swift, 2012; Nystrom, Ramamurthy, & Wilson, 2002; Westphal, Gulati & Shortell, 1997). Nevertheless, there are few papers covering product innovation adoption in the automotive market (Williams, Dwiwedi, Lal & Schwartz, 2009), most of them about alternative propulsion technologies adoption (Yeh, 2007; Zhang, Gensler & Garcia, 2011; Ozaki & Sevastyanova, 2011).

The main objective of this research was to identify and discuss possible differences in relative importance amongst the factors influencing product innovation adoption by OEM in the US and in Brazil.

## 2. INNOVATION ADOPTION BY ORGANIZATIONS

Innovation is a key element for organizations to survive and companies that fail to innovate are destined for irrelevance. This may come abruptly with the advent of a radical innovation implemented by a competitor, or when a company lags others that are continuously redesigning their products, processes, and business models.

Considering innovation as a process by which, based on market demand, new ideas are created and the means to implement it are devised (Tidd, Bessant & Pavitt, 2008), innovation adoption occurs at a point during this process in which the adopter (who can be an individual person, a group of individuals or an organization) decides to utilize this innovation as the best available alternative (Rogers, 2003).

In organizations, innovation adoption is associated with the adoption of a piece of business model, equipment, system, policy, program, product, process, or service created internally or bought from a different organization (Daft, 1978). This process is considerably more complex than individual adoption. It requires, among other factors, organizational disposition to innovate (Rogers, 2003; Damanpour & Schneider, 2006), which is itself influenced by characteristics both internal (such as individual aspects of leaders) and external (such as competitive pressure), in addition to cultural aspects (Büschgens, Bausch & Balkin, 2013).

The understanding of complex mechanisms and of the variables involved in the process of organizational innovation adoption is fundamental for those who formulate corporate strategies and for researchers alike. Tornatzky and Fleischer (1990) established three basic contexts that influence the process of decision and implementation of technological innovations: organizational, technological and environmental.

## 2.1 Innovation adoption in the automotive industry

The automotive industry has undergone major transformations since it was first conceived in the late 19th century. Initially designed as mechanical systems, vehicles have changed day after day to become complex, smart mechatronic systems, to the point of fully autonomous navigation being a concrete possibility in the industry's technological scenario.
The competition on first decade of the 21st century grew fiercer, mainly in the most valuable markets. This accelerated the development of innovative products by the hands of various players in the industry, often (but not always) coordinated by R&D centers at the manufacturers headquarters, who among other goals seek to reconcile the pressure for global standardization with local market demands (Wells, 2010; Bryant & Wrigley, 2015) and, at the same time, meet price targets, notably those companies competing in the Chinese, Indian and Brazilian markets.
The Brazilian automotive industry was established early in the second half of the last century. For decades, only four manufacturers managed local production, all of them using components made by Brazilian manufacturers and under severe government restrictions on imports. Starting in the 1990s, the Brazilian government loosened import rules to facilitate the access of major global vehicle and parts manufacturers, but also offering several tax incentives and asymmetric public policies to boost local innovation. Combined, these factors ended up yielding significant advancements in emission reduction and consumption of locally made vehicles (De Mello, Marx & Motta, 2016). Despite these initiatives, Brazilian automotive market is still characterized by demand for low technological content vehicles, with a continuous bias towards reducing production costs. The introduction of new technologies is strongly influenced by advancements on legislation, particularly on aspects such as safety and sustainability.

## 2.2 Conceptual model

Several theoretical models have been developed in an attempt to address the process of organizational innovation adoption, relating organizational level and the individual adopter within an organization (Frambach & Schillewaert, 2002), associating the complexity and size of the organizational structure with innovation (Damanpour, 1996), analyzing the relation between the characteristics of the innovation, its adoption and implementation (Tornatzky & Klein, 1982), studying the relation between organizational change, organizational structure and innovation (Damanpour & Gopalakrishnan, 1998) and evaluating the organizational, technological and environmental contexts as influencers of the process of adoption and implementation of technological innovations (Tornatzky & Fleischer, 1990).
Frambach and Schillewaert (2002), for instance, proposed a model with multiple levels of organizational innovation adoption including determinants on an individual level, placing perceived innovation characteristics at the core of their model. These perceived innovation characteristics (relative advantage, compatibility, complexity, trialability and observability) were taken from the seminal model proposed by Rogers (2003) and are the central focus of their framework, since these characteristics act as vectors of the innovation process, influenced by external vectors (suppliers and network externalities). The variable "uncertainty" was added, but cleverly broken down into technical, financial, and social uncertainty. According to authors, the traits of an adopter include organization size, organizational structure, and the innovativeness posture.
Most research studies on innovation adoption and diffusion analyze the domains of electronic commerce, information systems, IT, Internet, wireless communication and websites (Williams et al., 2009). To the best of our knowledge, the proposal of a theoretical model for innovation adoption on automotive industry is innovative for academia and for the market.

To fill the gaps found in the literature, a theoretical model was developed to analyze the factors that influence the adoption of product innovation by vehicle manufacturers, applied to a context of a specific innovation (semi-active damping systems) with a view to evaluating the relative importance of influence factors for the Brazilian and US automotive markets. Table 1 illustrates the model's influence factors and dimensions along with the bibliography upon which the choice was based.

**Table 1 – Influence factors and dimensions for adoption of semi-active systems by OEMs**

| Dimension/Factors | Description | Reference |
|---|---|---|
| ***1. Influences of the Environment External to the Manufacturer*** | | |
| **1.1 Network externalities** | Degree to which manufacturers are influenced to adopt semi-active systems by other competitors that have already adopted the innovation | Frambach & Schillewaert (2002); Cao, Li & Wang (2014); Hameed *et al.* (2012); Ukobitz & Faullant (2021); Jacob & Teutenberg (2022) |
| **1.2 Market pressure** | Degree to which innovation adoption is necessary to maintain the manufacturer's competitive position against competitors | Tornatzky & Fleischer (1990); Frambach & Schillewaert (2002); Lin (2014); Chong & Zhou (2014); |
| **1.3 Market demand** | Tendency for end consumers and users of vehicles to adopt the innovation; | Rogers (2003); Venkatesh *et al.* (2012); |
| **1.4 Supplier** | Influence of the number of suppliers and whether supply takes place globally | Ozorhon *et al.* (2014); Bunduchi *et al.* (2011); Chong & Zhou (2014) |
| **1.5 Legislation** | Influence of normative pressure (legislation) on innovation adoption | Cao *et al.* (2014); Zailani *et al.* (2015); Wu *et al.* (2003); |
| **1.6 Technology trends** | Influence of technology trends on innovation adoption | Ozaki & Sevastyanova (2011); Zhang, Gensler & Garcia (2011); Yeh (2007); |

| ***2. Perceived Innovation Characteristics*** | | |
|---|---|---|
| **2.1 Relative advantage** | Degree of perceived technical, financial, and operating advantages of the system compared to traditional damping systems; | Rogers (2003); Frambach & Schillewaert (2002); Damanpour & Schneider (2008); |
| **2.2 Complexity** | Degree of cognitive difficulty (understanding how the system operates) and its use by members of the manufacturer | Rogers (2003); Frambach & Schillewaert (2002); Tornatzky & Klein (1982); Damanpour & Schneider (2008) |
| **2.3 Trialability** | Degree to which the system was tested at a limited scale, or the ability of the supplier to demonstrate the system's functionality | Rogers (2003); Frambach & Schillewaert (2002); Chong & Zhou (2014) |
| **2.4 Uncertainty** | Degree of technical, financial, and social uncertainty from the implementation of the innovation at the manufacturer; | Rogers (2003); Frambach & Schillewaert (2002); Wang & Cheung (2014); Kitchell (1995) |
| **2.5 Cost** | Influence of cost with the adoption of the innovation by the manufacturer | Damanpour & Schneider (2008); Bunduchi *et al.* (2011); Lin (2014) |
| **2.6 Quality** | Influence of the product quality as perceived by the manufacturer and by the end customer | Damanpour & Schneider (2008); Premkumar & Roberts (1999); Nahm *et al.* (2003); Chao *et al.* (2007) |

| | | |
|---|---|---|
| ***3. Innovation Management*** | | |
| **3.1 Supplier participation** | Degree to which the supplier participates in the development of the innovation | Tornatzky & Fleischer (1990); Chong e Zhou (2014); Martin *et al.* (2016) |
| **3.2 Access level** | Level of access the manufacturer has to information from the supplier technology | Tornatzky & Fleischer (1990); Chong & Zhou (2014); Nahm *et al.* (2003) |
| **3.3 Innovativeness** | Propensity of the adopter to gamble on radical innovations (market launch strategy – in niche or mass segments) | Rogers (2003); Damanpour & Schneider (2006); Zammuto & O'Connor (1992); Nagy *et al.* (2016); Blichfeldt & Faullant (2021) |
| **3.4 Development at HQ** | Influence of the development strategy (centered around HQ or pursued totally or partially at the subsidiary) on innovation adoption | Baglieri *et al.* (2014); Baglieri *et al.* (2010); Costa *et al.* (2015); Birkinshaw e Hood (1998) |

## 3. METHODOLOGY

The main objective of the research was to identity the difference, if any, between the relative importance of factors influencing product innovation adoption by organizations in the automotive sectors in the US and in Brazil. Moreover, it sought to discuss the reasons for such differences, if any were to be found.

A qualitative approach was chosen, since this model suits the analysis of a complex topic that has seen little research (Yin, 2010; Creswell, 2007), namely the patterns of product innovation adoption in organizations of the automotive industry. After the analysis of the various research methods, basic research was chosen for this study since "the purpose of basic research is to establish the patterns to understand and explain phenomena using existing models or testing new theories, demanding a long period of time and great focus from the researcher for accurate, correct and reliable results" (Patton, 1990, p. 153).

This study used research data analysis, in which a phenomenon is studied in different places with the goal of obtaining multiple perspectives on the event of interest (Creswell, 2007). To evaluate the relative importance of the factors that influence innovation adoption in the two countries, the authors selected vehicle manufacturers and suspension and damping system suppliers established both in Brazil and in the US. Respondents include executives from the engineering, R&D, marketing and sales departments from plants in both counties. Semi-structured interviews (Brannen, 1992) were conducted with twenty professionals. The script was submitted for pre-testing with four senior professors from the field of innovation management with extensive academic and market experience. The remarks made by these professors were incorporated into the original script.

### 3.1 Data collection and analysis

Data from the Brazilian research was collected between September and October 2017. Information was obtained from representants from six manufacturers, four suppliers of dampers and components for suspension systems, and one trade association from the automotive field. The US research consisted of interviews with four professionals, conducted over April and May 2018. All interviews were recorded and transcribed for later reference.

The second stage of the research was conducted along June and July 2018. It aimed to identify, for each market, the three most important and three less important influence factors for semi-active damping systems adoption by vehicle manufacturers. A separate document was prepared with this result, with selected comments from respondents and theoretical considerations. This document was sent by email to the respondents in Brazil and in the US, asking whether these professionals agreed with the classification of influence factors. Additionally, the respondents were asked to provide further comments, suggesting alternative factors to those initially determined.

Data was classified into categories according to the theoretical model, and the responses given by the individuals in Brazil and in the US were compared. The purpose was to weight up the relative importance of influence factors in both scenarios (Miles, Huberman & Saldana, 2014). The raw data was codified in order to protect the confidentiality of respondents and the classified with N-VIVO11 Pro. The use of this software proved to be very appropriate as a form to instrumentalize the qualitative analysis of the non-structured data from the interviews.

It is important to stress that the data analysis was made in a particular fashion at each stage of the research. The analysis in the first stage was meant to identify the relative importance of factors and dimensions for each market considering the theoretical model (Miles, Huberman & Saldana, 2014). The analysis in the second stage compared the three most important and the three least important factors in both markets.

## 4. RESULTS AND DISCUSSION

### 4.1 The Innovation: Semi-active damping systems

The role of dampers is to reduce the impact of pavement imperfection on the occupants of a moving vehicle. Dampers are integrated into the suspension of vehicles and play a fundamental role in cruise control and passenger comfort while also having crucial implications for occupant safety. In "passive" damping systems, damping forces are controlled via internal valves, which are calibrated to ensure a compromise between safety and stability. After the valves are calibrated, the damper is sealed shut and interfering in its performance no longer becomes possible (Dixon, 2007; Reimpell, Stoll & Betzler, 2001).

"Adaptive" and "semi-active" systems were introduced in 1985 with the advancements of embedded electronics, implementing a system that electronically adjust the damping curves based on a series of factors, with the goal of continuously optimizing the compromise between comfort and safety. In this system, sensors located on strategic spots of the vehicle feed real-time information on pavement ruggedness, curves, and brake usage to a control processing unit. This CPU commands the electromagnetic valves inside the dampers, changing the damping forces at regular intervals, allowing for a more precise control. Semi-active damping systems were first introduced in luxury vehicles. But as years went by, they were incorporated in other segments, following a trend towards increased embedded electronic content in vehicles. It is worth stressing that studies on the adoption of these types of product and system innovations are not common in the literature.

### 4.2 Results of the research in the Brazilian automotive market

A detailed analysis on the interviews were performed to evaluate the relative importance of factors that influence the adoption of semi-active damping systems by Brazilian OEMs. Under the dimension "external environment influences" respondents highlighted "network externalities," "market pressure," "market demand," "local and global supplier," and "legislation". Surprisingly, the factor "technology trends" was not marked as an influence on the adoption of this innovation by manufacturers established in Brazil. This result contradicts several indications in the literature, among which are Rogers (2003); Tornatzky & Fleischer (1990); Damanpour & Schneider (2006); Damanpour & Gopalakrishnan (1998); Venkatesh et. al. (2012) and Zailani et. al. (2015).

Respondents' answers concerning the influence factors under the dimension "innovation characteristics as perceived by the manufacturer" show that the factor "relative advantage" of the innovation as manufacturers see it (technical, financial and organizational) is relevant to the adoption decision. This confirms aspects that have already been presented in the literature

(Rogers, 2003; Tornatzky & Klein, 1982; Damanpour & Schneider, 2008; Premkumar & Roberts, 1999). Respondents did note, however, that the high cost of such system is a considerable disadvantage for adoption in Brazil.

The factor “complexity” of smart damping systems may or may not influence the decision of a manufacturer to adopt this innovation, depending on the product development strategy pursued by the company. In those cases, where system development is centralized and handled by the supplier (“black box”), the degree of “complexity” of the innovation does not influence the adoption of said innovation, whereas in companies that develop the system, interacting and impacting supplier’s design, this influence is observed. The influence of the factor “trialability” on the adoption of semi-active damping systems was confirmed unanimously by respondents from manufacturers and system suppliers. With respect to the factor “uncertainty,” two risks were mentioned: Brazilian market not adopting the innovation (market risk) and the risk of quality issues resulting from any failure to adapt a design to the condition of Brazilian roads.

Regarding the factors “cost” and “quality,” the technical characteristics of semi-active damping systems have made their cost deservedly higher compared to passive systems, to the point of virtually making their adoption inviable to manufacturers operating in the Brazilian market.

The results of the research on the dimension “innovation management” show that the factor “supplier participation” in the development of vehicle suspensions that use smart damping systems may or may not influence the adoption decision by the manufacturer, something that studies conducted in other market segments had already shown (Martin et. al., 2016; Chong & Zhou, 2014). Most manufacturers prefer to follow the black box system, in which inputs into design are differed to the supplier, who develops an end-to-end solution without any inputs from the manufacturer. There are, however, manufacturers that opt to share the development process with suppliers from the very beginning of a vehicle’s design.

A similar trend was found about the influence of the factor “access level” about the smart damping systems technical specifications that a manufacturer has from the supplier. This corroborates studies conducted in other segments (Weigelt & Sarkar, 2009; Hong & Zhu, 2005). Most manufacturers and system suppliers established in Brazil have their innovation development strategies centered in their headquarters. Therefore, the way these innovations are adopted and implemented in local markets follows the black box system.

Thus, customer access to detailed technical information about the innovation is not a determinant. In those cases, the Brazilian subsidiary of a manufacturer is the one adopting it. Nevertheless, since this is a system that relies on adaptation to local road conditions, limited access to technical information on both sides is necessary and convenient, as confirmed by the interviews. To those manufacturers established in Brazil whose development strategy consists of learning in detail a supplier’s design, this influence is preserved.

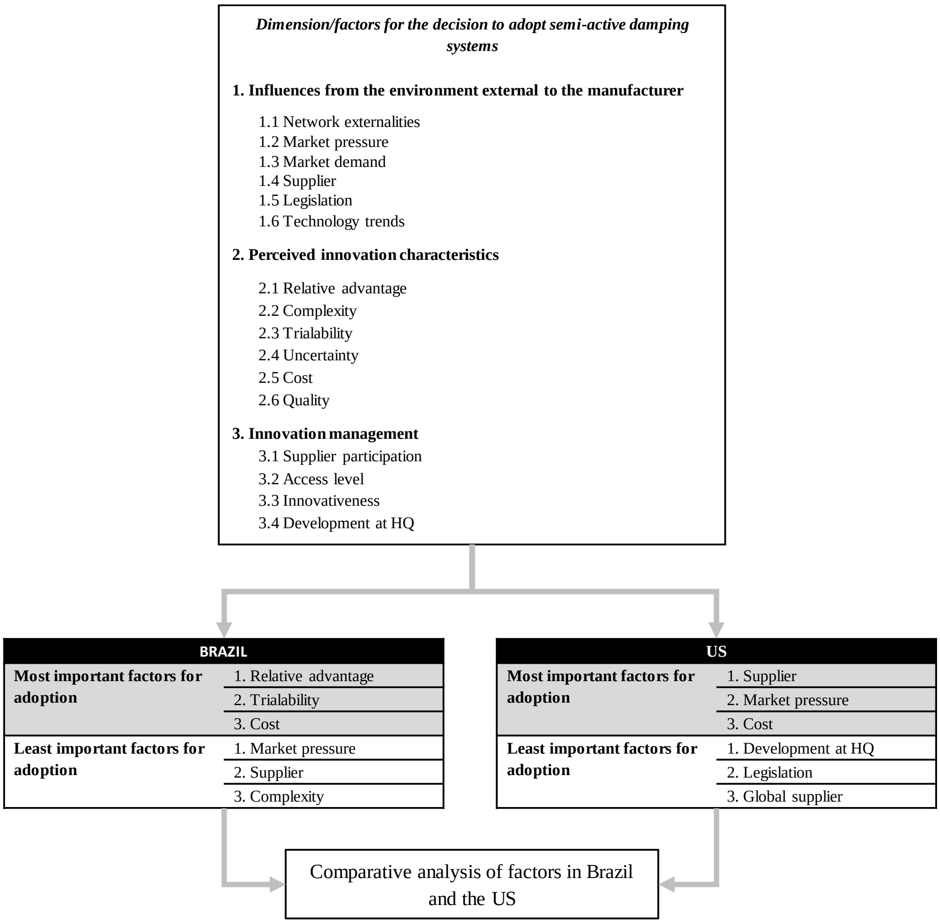
The influence of the factor “innovativeness” was evaluated by asking manufacturers and suppliers about their strategy to launch semi-active damping systems in the Brazilian market. This factor is influenced by whether the executives who evaluate the decision to adopt the innovation have (or have not) an innovation mindset (Roberts et. al., 2021; Blichfedlt & Faullant, 2021; Wu et. al, 2003; Lin, 2014; Ozorhorn et. al., 2014). The answers indicate the conservative and cost-reduction bias of Brazilian manufacturers. Launching the system as an optional in vehicles with a high sales price was the strategy suggested by respondents, showing a low disposition to introduce radical innovations in the mass market. The factor “Development at HQ” evaluates how much influence a development strategy (HQ-centered or at least partially conducted by the subsidiary) exerts on innovation adoption. According to the interviews there are cases in which development (and consequently adoption decision and implementation) is made entirely at headquarters. In such instances, adoption in the subsidiary’s market is strongly dependent on market factors. It was mentioned also that there are cases in which the decision to adopt and implementation the innovation is made by the subsidiary, a process known as

"reverse innovation" (Govindarajan et al, 2012), and the subject of many studies conducted in the automotive sector (Baglieri et al., 2014; Costa et al., 2015; Da Matta et al., 2015).
After mapping the importance of each factor against the conceptual model, it was performed an analysis aiming to determine the three factors that, according to respondents, were most important for adoption and the three that were least important. The result was compared to other studies and corroborated the relative importance of factors "relative advantage" (Jeyaraj et al., 2006; Hammeed et al., 2012; Premukamar & Roberts, 1999; Wang et al., 2010), "trialability" (Jeyaraj et al. 2006; Hammeed et al., 2012; Carlo et al., 2012; Glöbsich et al., 2017; Seitz et al., 2015) and "costs" (Bunduchi et al., 2011; Lin, 2014) for adoption.
Conversely, the factor "market pressure," while relevant to adoption according to the literature (Tornatzky & Fleischer, 1990; Frambach Schillewaert, 2002; Lin,2014; Chong & Zhou, 2014; Wang & Cheung, 2014) was considered of low importance, notably due to the weak demand in the Brazilian market for semi-active damping systems. Analogously, the expected strong relevance of factors "supplier" (Ozorhon et al., 2014; Bunduchi et al., 2011; Chong & Zhou, 2014) and "complexity" (Rogers, 2003); Frambach & Schillewaert, 2002; Tornatzky & Klein, 1982; Damanpour & Schneider, 2008) did not prove true in the context of the present study.

### 4.3 Results of the research in the US market and a comparison against the results of the research in the Brazilian automotive market

One vehicle manufacturer and two suspension system suppliers were selected for the research stage with manufacturers and suppliers established in the US market. The same set of questions used previously were used for the interviews (managers from engineering and sales departments). The goal was also the same as the Brazilian phase: to evaluate the relative importance of factors that influence the adoption of semi-active damping systems.
The results of this second round of interviews were compared with those from the interviews with respondents at companies established in Brazil. The result was the identification of the three most important and the three least important factors influencing innovation adoption in the view of adopters from both countries (see Figure 1).

**Figure 1 - Conceptual model for a comparative analysis of the importance of factors that influence the adoption of semi-active damping systems (Brazil and the US)**




Shown in Table 3 below are a summary of the comparative analysis between the two groups of respondents and a debriefing describing each dimension and the bibliography on the topic.

**Table 3 - Summary of the analysis of the most and least important factors for the decision to adopt semi-active damping systems (Brazil and the US)**

| ***Influence factor*** | ***Relative importance*** | ***Comment*** |
|---|---|---|
| Relative advantage (Perceived technical, financial and operating advantages of the semi-active damping system compared to traditional dampers) | Brazil: One of the three *most* important, corroborating theory predictions (Jeyaraj et al., 2006; Hammeed et al., 2012; Wang et al., 2010)<br>US: Considered among those neither the most important nor the least important. | *Technical advantage:* The semi-active damping system provides greater comfort to occupants, coupled with improved stability and safety, compared to the traditional damping system.<br>*Financial advantage:* The cost of development and manufacture of semi-active damping systems is higher compared to traditional dampers. According to the respondents, Brazilian consumers are not willing to pay for this innovation. Therefore, the technical advantage is practically voided by the negative influence of this subfactor. Conversely, in the US, where the luxury vehicle segment is significant, this influence is not found, and the technical advantage prevails. |
| *Supplier* (Influence of the number of semi-active damping system | Brazil: One of the three *least* important. | The adoption of semi-active damping systems involves advanced technologies that are not entirely grasped by OEMs and that are used only in a few segments of the US market (luxury or |

| *Influence factor* | *Relative importance* | *Comment* |
|---|---|---|
| suppliers on the OEM's market) | US: One of the three *most* important, corroborating theory predictions (Dodourova & Bevis, 2014; Mondragon et al., 2009; Hammeed et al., 2012) | sports cars). For this reason, geographic proximity between suppliers and manufacturers facilitates communication and better adjustments to the product. In the US, there are at least five suppliers of this type of technology with differentiated technical solutions. This allows an OEM to choose one that fits its product the most. The number of suppliers influences, to a meaningful extent, the adoption of this innovation in the US.<br>In Brazil, as of the time the research was conducted, there were only three semi-active dampers suppliers. |
| *Global supplier* (Influence of the supplier of semi-active damping systems, local or global, on innovation adoption) | Brazil: Considered among those neither the most important nor the least important.<br>US: One of the three *least* important. | While OEMs supply to all countries in which they make vehicles, in the US the local presence of suppliers of complex technology systems, as is the case with semi-active dampers, is important for communication and for adapting the innovation to local conditions, regardless of whether this supplier has a global sales agreement with the customer. |
| *Trialability* (Proof and concept, degree to which the semi-active damping system was tested, even at a limited scale, by the OEM, or the system supplier managed to demonstrate proper functionality) | Brazil: One of the three *most* important, corroborating the theory predictions (Jeyaraj et al. 2006; Hammeed et al., 2012; Carlo et al., 2012; Glöbsich et al., 2017; Seitz et al., 2015)<br><br>US: Considered among those neither the most important nor the least important. | Tests are conducted during the proof-of-concept and business plan writing stage. After the plan is approved, the innovation is adopted before entering the production implementation stage. According to the interviews, this stage is carried out in the OEM HQ. In the case of Brazil, semi-active damping systems would be supplied as black box, with some degree of customization for local conditions. |
| *Market pressure* (Degree to which the adoption of semi-active damping systems is necessary to maintain an OEM's competitive position) | Brazil: One of the three *least* important.<br><br>US: One of the three *most* important. | US consumers are increasingly more demanding. This forced traditional OEMs to invest in new technologies. Despite being small, the segment of semi-active damping system customers is sufficient for OEMs to break even.<br>In the Brazilian market, the sales of luxury vehicles are of little significance compared to the substantial lead of "B" and "SUV" segments. Demand for this technology is practically non-existent. Therefore, there is no competition between manufacturers established in Brazil when it comes to the production of vehicles equipped with semi-active dampers. In the US, the luxury vehicles segment is small in terms of percentages, but profitable. |

| ***Influence factor*** | ***Relative importance*** | ***Comment*** |
|---|---|---|
| *Cost*<br>(Influence of cost on the adoption of semi-active dampers by an OEM) | Brazil: One of the three *most* important.<br><br>US: One of the three *most* important, corroborating the theory predictions (Hammeed et al., 2012; Jeyaraj et al., 2006; Premkumar & Roberts, 1999; Tornatzky & Klein, 1982) | Considering that traditional damper technology meets the comfort and safety demands of "B" and "SUV" segment consumers, the only way to introduce this innovation in these segments would be to reduce development and production costs. This is a challenge that proves to be inviable considering the current state of manufacturing technology.<br>In the US market, semi-active dampers will soon equip not only luxury vehicles, but vehicles in other segments as well, something that has required OEMs to reconsider their product strategies, particularly with a view to reducing production costs. |
| *Development at HQ*<br>(Influence of the semi-active damping system development strategy: whether centered around HQ or pursued at least partially by the subsidiary) | Brazil: Considered among those neither the most important nor the least important.<br><br>US: One of the three *least* important, contradicting the predictions in the literature.<br>(Da Matta et al., 2015; Lema et al., 2015; Costa et al., 2015; Baglieri et al., 2014) | Semi-active dampers are a mature technology. For this reason, it would be easier to adapt developed products to the local market. Local supplier presence is a competitive advantage, according to the interviews, once it facilitates communication and adaptation of systems to vehicles made locally. In the case of Brazil, the decisions to adopt and implement innovations of this magnitude are made by HQ, with adaptations. |
| *Legislation*<br>(Influence of normative pressure on the adoption of semi-active damping systems) | Brazil: Considered among those neither the most important nor the least important.<br><br>US: One of the three *least* important, contradicting the predictions in the literature<br>(Ozaki & Sevastyanova, 2011; Glöbisch et al., 2017; Seitz et al., 2015; Palmer et al., 2018). | Dampers are not formally considered a safety component. For this reason, there is no specific legislation the requires semi-active dampers to be adopted in the US. However, suppliers of these types of systems are required to meet specific product legislation (e.g., packaging, eco-friendly materials) and the negotiations between OEM and supplier determine the product shipping conditions. In Brazil, the situation is similar seeing as, according to respondents, the legislation is unlike to require the implementation of semi-active dampers, as opposed to what happened with anti-lock braking systems (ABS) and stability control systems (ESP). |
| *Complexity*<br>(Degree of difficulty the manufacturer's technicians must comprehend the technical details and | Brazil: One of the three *least* important.<br><br>US: Considered among neither the | In the case of Brazil, where the semi-active system would be sold as black box, even if the segment were to become profitable, complexity would not influence the adoption process since development is made at the HQ of the supplier and the OEM, with the product being adapted to the vehicles |

| *Influence factor* | *Relative importance* | *Comment* |
|---|---|---|
| operation of semi-active damping systems) | most important nor the least important, contradicting the predictions in the literature (Jeyaraj et al., 2006; Hammeed et al., 2012; Carlo et al., 2012; Mondragon et al. 2009). | manufactured in the local market. As for the US market, the higher the technical expertise of a manufacturer, the more this manufacturer will demand to learn about the supplier's development capability and the technical details of the innovation, which in the case of semi-active dampers means software codification for compatibility and calibration of those components with the vehicle's electronic information networks. |

## 5. CONTRIBUTIONS AND FINAL CONSIDERATIONS

The main objective of this article was to identify the relative importance of the factors that influence the adoption of product innovation by automotive market organizations in a developed country and in a developing country. In addition, it raised a discussion regarding the reasons behind the differences found in the field. Table 4 illustrates the differences in the relative importance of factors.

**Table 4 - Comparative analysis of factors that influence adoption decision (Brazil and the US)**

| Factor | Comments |
|---|---|
| **Relative advantages** | The benefits perceived by manufacturers and consumers are evaluated based on cost-effectiveness. This indicates that this factor is relevant in both markets (Brazil and the US), although its influence is stronger in Brazil. |
| **Suppliers** | The number of suppliers does not influence adoption in either market. Technical expertise and support, on the other hand, are differentials when it comes to adoption. |
| **Global suppliers** | What influences adoption in the US market is not global supply, but rather optimized local solutions. |
| **Trialability** | Proof of concept exercise tests during the business plan stage influence adoption. But in the Brazilian market, the implementation of the innovation takes place as black box. Marketing campaigns facilitate adoption by end consumers. |
| **Market pressure** | The competition market clearly exerts influence on the decision to adopt the new technology. However, it is worth noting that cost-effectiveness will carry heavier weight with this decision than technology offered by competitors. |
| **Cost** | This factor exerts strong influence on the decision to acquire or not to acquire the technology in both markets. However, while the US seeks low-cost technology, in Brazil the decision is not to adopt the technology, based on the assumption that consumers are not willing to pay for it. |
| **Development at HQ** | Smart dampers have already been developed and are being produced in developed countries. The ability to customize a product is an advantage for adoption. |
| **Legislation** | There is no legislation that requires smart dampers to be adopted, in both Brazil and in the US. |
| **Complexity** | This factor is considered secondary despite exerting some amount of influence. This is because OEMs prefer to thoroughly learn about the potential of a technology rather than buy it as black box. |

| Factor | Comments |
|---|---|
| | In Brazil, this factor was reported as one of the three least relevant in the decision to acquire the technology. |

Studies on the adoption of product innovation by organizations in the automotive industry are not frequent in the literature and, when they are conducted, they usually focus on the adoption of alternative propulsion systems (Yeh, 2007; Zhang, Gensler & Garcia, 2011; Sperry, 2004; Ozaki & Sevastyanova, 2011). The main contribution of this article to the literature was to demonstrate that manufacturers give different levels of importance to influence factors when deciding whether to adopt a product innovation, due mainly to the automotive market dynamics. Such is the case of the factor "market pressure," which has limited importance in the Brazilian automotive market, steered essentially by cost, as opposed to the key importance given to it by the US market, where luxury vehicle consumer demand for innovation at competitive prices prompts manufacturers to differentiate their products. Another contribution of this study to researchers of organizational innovation adoption was to demonstrate that, in addition to the relative importance of factors varying from country to country, there is an interrelation of factors such as innovation development at headquarters interfering with the influence of the factor "trialability" on innovation adoption. By contrast, when reverse innovation takes place, partnering and interacting with the suppliers proves necessary, increasing the demand for experimentation during the adoption decision stage (Mondragon et al., 2009; Lema et al., 2015). The study showed that the success of innovation adoption depends on the capability to understand the specificities of the different countries.

This article has limitations inherent in the basic qualitative research method itself, and the fact that the study included only a limited number of companies in the markets of two countries. Future studies could increase the number of companies and the range of countries where the comparison of the importance of factors takes place. Quantitative approaches could also unearth important information about the influence factors and their correlations.

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