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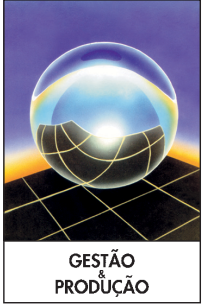

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Innovation by knowledge exploration and exploitation: an empirical study of the automotive industry

Inovação por exploração e explotação do conhecimento: um estudo empírico do setor automobilístico

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Abstract: In face of dynamic environment, such as the automotive sector, organizations are challenged to establish strategic flexibility through innovations, which require knowledge exploration and exploitation. Previous studies point out that the combination of knowledge exploration and exploitation is the ideal strategy for innovation since it will lead organizations to access new technologies and refine and improve the dominant technology through the exploitation of primary knowledge. Most studies on the subject focus their contributions on analyzing the impact of knowledge management initiatives and the knowledge exploration and exploitation on the company's innovative and financial performance; however, few studies have investigated the organizational factors that sustain the knowledge exploration and exploitation. The research results show that the processes of exploration and exploitation are impacted differently by five contextual factors considered in this research (human resource management, collaborative leadership, learning culture, autonomy and information technology (IT) systems). While exploration is most impacted by a learning culture, autonomy and IT systems, exploitation is closer related to collaborative leadership and learning culture.

Keywords: Knowledge exploration; Knowledge exploitation; Knowledge management; Innovation; Automotive industry.

Resumo: *Diante de ambiente dinâmico, como é o caso do setor automobilístico, alvo deste estudo, as organizações são desafiadas a estabelecer flexibilidade estratégica, conquistada por meio de inovações, que exigem a exploração e explotação do conhecimento. Estudos prévios apontam que a combinação de exploração e explotação do conhecimento é a estratégia ideal para inovação, pois a organização acessará novas tecnologias por meio da exploração de novos conhecimentos e refinará e aperfeiçoará a tecnologia dominante por meio da explotação do conhecimento primário. Grande parte dos estudos sobre o tema foca suas contribuições em analisar o impacto das iniciativas de gestão do conhecimento e da exploração e explotação do conhecimento sobre o desempenho inovativo e financeiro da firma; entretanto, percebem-se poucos estudos que investigam os fatores organizacionais que sustentam os processos de exploração e explotação do conhecimento. Os resultados da pesquisa mostram que os processos de exploração e explotação do conhecimento são impactados de forma distinta por cinco fatores contextuais, considerados nesta pesquisa: gestão de recursos humanos, liderança colaborativa, cultura de aprendizagem, autonomia e sistemas de tecnologia de informação (TI). Enquanto exploração é mais impactada por cultura de aprendizagem, autonomia e sistemas de TI, explotação está mais relacionada com liderança colaborativa e cultura de aprendizagem.*

Palavras-chave: *Exploração do conhecimento; Explotação do conhecimento; Gestão do conhecimento; Inovação; Indústria automobilística.*

1 Introduction

Previous studies indicate that knowledge is the main organizational resource able to generate a competitive advantage through innovation (Torugsa & O'Donohue, 2016; Grant, 1996). In this context, knowledge management (KM) has become one of the most influential models in the field of Managerial

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Sciences. Recent surveys show that KM influences the performance of firms as it offers an effective framework for implementing innovation strategies (Moustaghfir & Schiuma, 2013; Lee et al., 2013; Lin, 2014).

A large number of research aims to relate the generic processes of KM such as creation, retention, distribution and use of knowledge to the firm's innovative or financial performance (Chen et al., 2010; Lee et al., 2013). It is noted in the literature that little attention has been given to the impact of the contextual factors of the organization that support the firm's KM process and innovation. Some studies examine the influence of one factor in isolation in relation to KM and innovation, as occurs in Martins & Meyer (2012) and Zangiski et al. (2013), who focus on the relationship between human resources and KM; Corfield & Paton (2016) and Marouf (2016), who deal with the relationship between organizational culture and KM; and Gonzalez et al. (2014), Chen et al. (2010) and Chen & Huang (2007), who focus on the relationship between organizational structure and KM; and also Kane & Alavi (2007) who relate Information Technology (IT) systems and KM. However, White & Cicmil (2016) warn that it is essential to treat these factors simultaneously, for analyzing a single factor in isolation can lead to erroneous conclusions.

The literature addresses the factors related to KM as "contextual factors of the organization" (Gonzalez & Martins, 2014; Martins & Meyer, 2012; White & Cicmil, 2016) or "critical factors for the success of KM" (Lee & Choi, 2003; Gold et al., 2001; Lin, 2014). In this study, the former terminology is used. These factors establish the organizational behavior, in what concerns values and beliefs that guide individuals, integration and forms of organization of employees into groups, level of training of employees, and the posture assumed by the company's management. Without the effort to develop these factors, any organizational initiatives geared towards KM ends up not creating the expected benefits (Gonzalez & Martins, 2014).

Since these factors are developed internally and in very different ways, and although these factors directly influence the KM process, it can be affirmed that organizations have, accordingly, distinct manners and capabilities of innovation (Patterson & Ambrosini, 2015; Gonzalez et al., 2014; Chen et al., 2010; Torugsa & O'Donohue, 2016). Thus, the main purpose of this article is to analyze the relationship between the contextual factors that underpin KM and the type of innovation practiced by companies in the automotive industry, in relation to knowledge exploration and exploitation.

The choice of this industry can be justified in two senses. The first refers to its importance within Brazilian industry. According to IBGE (2015), this sector employs 5.6% of the Brazilian industry's workers and is responsible for 19.8% of the industrial GDP. In addition, it is worth noting that companies from the automotive industry mobilize knowledge in order to achieve, mainly, incremental innovations, focused on productivity improvements and adjustments to the products, and also on radical innovations, geared towards the implementation of new technologies in the components of the products and processes (Gonzalez & Martins, 2014).

2 Innovation based on knowledge exploration and exploitation

Innovation is crucial for companies to adapt to dynamic environments and to create strategic flexibility. Prior studies classify innovation as explorative or exploitative depending on the proximity to technologies, products, services and consolidated processes (Patterson & Ambrosini, 2015; March, 1991). Exploratory innovation is developed to meet emerging demands of customers or new markets, promoting the introduction of new technology in products, services and processes that are not yet operable. Exploratory innovation requires new knowledge and information, which in turn requires a consolidated primary knowledge base. The absence of primary knowledge will restrict the acquisition of new knowledge that supports the process of innovation through exploration (Grant, 1996). Differently, exploitative innovation is conducted to meet the needs of customers and current markets, expanding the existing products and services, and also refining and improving the efficiency of the processes. In comparison with exploratory innovation, exploitative innovation is based on knowledge and information associated with primary knowledge and skills.

March (1991) emphasizes that the results associated with exploration are more variable and long-term, while the results relating to exploitation are more precise and short-term. In other words, companies that exploit new knowledge generate great variation in performance, while the use of exploitation leads to a more stable performance. Levinthal & March (1993) and Ganzaroli et al. (2016) argue that it is important for companies to maintain an appropriate balance between exploration and exploitation to increase competitiveness.

Holmqvist (2004) found that exploration and exploitation require significantly different structures, processes, strategies, capacity, and culture. In general, exploration is associated with an organic structure,

systems that are not rigid, improvisation, and autonomy. Exploitation, on the other hand, is associated with mechanical structures, more rigid systems, routine, control, and bureaucracy (Holmqvist, 2004).

Crossan & Berdrow (2003) and March (1991) consider that there is tension between exploration and exploitation. If on the one hand, adaptation to the environment can promote inertia, in addition to reduction of the company's capacity to adapt to new opportunities, on the other, trying new alternatives reduces the speed at which the existing competences are improved and refined (March, 1991).

According to Levinthal & March (1993), Ganzaroli et al. (2016) and Gupta et al. (2006), organizations must balance their exploration and exploitation strategies. The authors argue that an excessive focus on exploitation results in organizational "short-sightedness," hindering innovation and leading to a process of obsolescence. Similarly, excessive exploitation is also equally destructive, because organizations can enter into a cycle of failure – research – change – failure. The authors argue that based on the failures, polls are originated in the organizations, which support the changes that, in turn, will result in new failures, initiating a new cycle of research. These organizations suffer from never gaining the return of their acquired knowledge. Crossan & Berdrow (2003) believe that there are important implications in balancing exploitation and exploration. According to the author, the organizations that manage knowledge well are competent in developing innovative ideas, as well as in institutionalizing and redeeming individual learning.

There is a complementary effect between the two strategies: exploitation promotes static optimization, while exploration supports dynamic optimization. The success of a company when competing in stable environments involves the exploitation of the consolidated competences, while surviving in dynamic environments involves the development of new competences. Thus, the two strategies are essential to maintain a competitive edge, and their combination is implied in recent concepts that deal with the organization's dynamic capabilities (Eisenhardt & Martin, 2000).

3 Contextual factors that support KM

Recent studies in the fields of Economics and Business Administration contribute to the development of the theory of the knowledge-based firm, which puts the processes of creation, retention, distribution and use of knowledge as the firm's primary existential reasons (Grant, 1996). This theory requires knowledge to be the main strategic resource, for, when properly managed, it enables the company to create cultural, intellectual, social and economic value (Zack et al., 2009). In this context, it is acknowledged that the company is an entity that is continuously transforming its acquired knowledge through its dynamic capabilities, in a prospect of knowledge exploration and exploitation (Kogut & Zander, 1992).

From a strategic point of view, Grant (1996) recognizes two types of contributions from KM. The first refers to the recognition of two kinds of knowledge – tactical and explicit knowledge – that require different approaches for their management. While explicit knowledge is presented in coded form, tacit knowledge is manifested through abilities and skills intrinsic to people (Zack et al., 2009). The second contribution concerns the way in which the knowledge is renewed or transformed. Grant (1996) proposes that organizations can transform knowledge into a continuum between exploitation, that is, using the same primary knowledge base in order to achieve incremental improvements; and exploration, which focuses on research, discovery and experimentation in order to modify the primary knowledge acquired (March, 1991).

These two contributions evoked by Grant propose that KM should be addressed as a social and technical phenomenon (Van Dijk et al., 2016; Lin, 2007). In this context, the KM process steps are conditioned to organizational development, associated with the organization's contextual factors, the IT systems in particular being support mechanisms related to the processing, retention and distribution of explicit knowledge through integrative applications, such as knowledge repositories (Zack, 1999), and also enabling the exchange of tacit knowledge through interactive applications, such as discussion boards (Zack, 1999).

Analyzing the contextual factors that support KM, the organizational culture is an often listed component (Corfield & Paton, 2016; Marouf, 2016; Chen & Huang, 2007; Gonzalez & Martins, 2014; Lin, 2014). The success of KM depends on the integration of strategy and vision with organizational culture and structure to promote the exchange of knowledge, experimentation, appropriate degree of autonomy and leadership support, and also the motivation and development of employees who retain the primary knowledge (Gold et al., 2001). Heisig (2009) identified four categories related to contextual factors that support KM: factors related to people, which include learning culture, human resource development and leadership; factors related to the organization, concerning the organizational structure; factors related to management processes,

with regard to the organizational strategy; and factors related to technology, which concern the IT systems.

In further discussing the identification of these critical factors, we assessed the proposals of some authors. Chourides et al. (2003), highlight the factors related to organizational strategy, human resource management (HRM) and IT. Davenport et al. (1998) conducted an exploratory study in 24 companies and established eight critical factors for KM: economic performance, clear language, flexible organizational structure, multiple channels for knowledge transfer, "friendly" culture, technical infrastructure, motivational and support management practices. Gonzalez & Martins (2014), based on a survey in companies in the automotive industry, identified eight critical factors: HRM, proactive leadership, learning culture, lean organizational structure, teamwork, primary knowledge, IT, incremental improvement and innovative strategy. Lin (2014) divides the contextual factors that support KM into two groups. The first, named technological context, includes the support of IT systems; and the second, named organizational context, consists of managerial support, learning culture and awards system. And, finally, the APQC (2003) establishes four critical factors for KM: leadership, learning culture, strategy and technology. In this way, based on Heisig's (2009) contribution and above-mentioned factors, this study considers the following contextual factors that support KM:

- Those related to people: HRM and collaborative leadership;
- Those related to organization: organizational learning culture and autonomy;
- Those related to technology: IT systems.

3.1 Human resource management

More modern approaches related to treatment of human resources start from premises devoted to the development of the workforce, for constantly improving competencies (Zangiski et al., 2013). KM initiatives depend on the willingness of people to share their knowledge and expertise (Quigley et al., 2007). No organization can generate knowledge without qualified employees (Figueiredo et al., 2016). Team members are the central element of the process of creation and use of knowledge, being the organization's duty to create mechanisms to develop and stimulate these processes (Figueiredo et al., 2016). In this context, HRM faces new and complex challenges. A HRM that supports knowledge creation and use aiming at innovation cannot feature traditional and eminently bureaucratic and mechanistic characteristics, but be guided by functions (Dominguez, 2011; Bontis & Serenko, 2007). HRM is understood in this study as the set of policies, systems, and practices that influence the behavior, attitudes, and performance of the team members to increase their learning capabilities, creating a learning-oriented culture (Razouk et al., 2009). The contemporary vision proposes that HRM should play roles that contribute to greater flexibility and greater organizational adaptability. These considerations give way to the first set of hypotheses:

H1a. HRM is positively related to innovation through knowledge exploration.

H1b. HRM is positively related to innovation through knowledge exploitation.

3.2 Collaborative leadership

KM combines technological and social activities performed by individuals that make up the organization, who create, store, share and utilize knowledge in order to achieve innovation and performance improvement. Leadership, in turn, plays a vital role of motivating, influencing and guiding individuals in that direction. Politis (2001) examined the relationship between transformational and transactional leadership, self-management, and several attributes of KM. Politis identified that these three leadership styles are related to the process of knowledge acquisition. He highlights the need for managers to promote the development of an organizational environment focused on the autonomy of individuals and groups. Politis' research results are aligned with other research such as those by Donate & Guadamillas (2011), Analoui et al. (2012) and Crawford (2005), who highlight the need for participatory and collaborative leadership in order to support the creative and innovative process within the organization. The role of collaborative leadership is based on encouraging the members of the firm and the voluntary application of individual talents aiming at the creation of new knowledge that generate a competitive edge (Donate & Guadamillas, 2011). Leaders should, therefore, encourage experimentation and facilitate the sharing of knowledge through the granting of autonomy, making use of guidance and confidence. Lakshman (2007) suggests that the perception of the leader about the importance of KM needs to manifest itself along two dimensions, one internal and one external. Internally, the understanding of the leader on the importance of KM is critical to the establishment of technological procedures and initiatives, focused on IT systems, and cognitive and social initiatives, which support

activities of innovation and performance improvement. This theoretical discussion gives way to the second set of hypotheses:

H2a. Collaborative leadership is positively related to innovation through knowledge exploration.

H2b. Collaborative leadership is positively related to innovation through knowledge exploitation.

3.3 Learning culture

Although learning is considered critical for organizational success, there are enormous challenges in terms of implementation of strategies that promote learning, creativity and innovation in organizational culture. The difficulties encountered in this process highlight the necessary changes in mental and cognitive structure of an organization's members (Donate & Guadamillas, 2011; Corfield & Paton, 2016). Organizational culture defines behavior patterns, values and beliefs that helps explain why different initiatives succeed or fail. Culture influences the behavior, feeling and way of acting of individuals (Mueller, 2012). Collaborative culture, in turn, proposes that the interests of the group and collective good take precedence over individual interests (Zheng et al., 2010). As a result, it is natural to assume that in environments where culture is collaborative, individuals are more willing to share their knowledge with the other team members, intensifying the flow of knowledge (Ma et al., 2014; Li, 2010). This discussion gives way to the third set of hypotheses:

H3a. Learning culture is positively related to innovation through knowledge exploration.

H3b. Learning culture is positively related to innovation through knowledge exploitation.

3.4 Autonomy

An organization with highly centralized structure requires that employees comply with guidance originated from a specific channel (Ho et al., 2014). However, this structural model slows down decision-making and restricts the flow of internal information and knowledge, suppressing the creative and innovation process (Lee & Choi, 2003). On the contrary, a decentralized organizational structure, which gives autonomy to employees, disperses authority to individuals and groups, offering opportunities to promote the creation and sharing of ideas, supporting the creation and transformation of knowledge (Lee & Choi, 2003).

Autonomy can be defined, therefore, as the amount of interdependence, initiative and freedom granted to employees for daily work-related decision making and executing (Chen & Huang, 2007). Autonomy gives employees individual freedom for seeking solutions to problems or for self-organizing networks of social interaction to solve these problems or even for planning and implementing improvements. Autonomy is the basis of self-organization and increases the likelihood of individuals becoming motivated to learn continuously through the creation of new knowledge and competences (Chen et al., 2010; Gonzalez et al., 2014). When the degree of autonomy is increased, managers do not specify targets, allocation of staff or lines of authority. This implies that employees start feeling more responsible for their own work and process. The organization thus encourages the creation of new ideas and knowledge, generating a more innovative context (Chen et al., 2010; Ho et al., 2014). This theoretical discussion gives way to the fourth set of hypotheses:

H4a. Autonomy is positively related to innovation through knowledge exploration.

H4b. Autonomy is positively related to innovation through knowledge exploitation.

3.5 IT systems

One of the main challenges in the field of KM resides in analyzing the contribution of IT systems and tools in relation to the firm's innovative performance and activity. Previous studies indicate that IT alone is unable to give a competitive edge and its effective use within the organizational context depends on its association with the development of other factors, in particular, those cited previously in this study (Xue et al., 2011; Donate & Guadamillas, 2011; Mohamed et al., 2006).

In relation to the increased flow of information and knowledge in the organization, it is important to stress the role of the IT systems. Organizations, divided into departments, units and branches, rely on an IT system that stores, formalizes and distributes explicit knowledge (Xue et al., 2011). Thus, this research considers that IT systems are facilitators of the KM process, it being up to individuals the action itself so that this stored and distributed knowledge assigns value to the organization.

Bansler & Havn (2004) highlight that tools such as Data Warehousing and Data Mining accelerate the learning process, support the autonomy of employees,

enable teamwork as well as access to information and knowledge. Therefore, this type of tool is capable of storing the best organizational practices (Gonzalez & Martins, 2014) and processing multiple combinations of analyses.

Other tools such as the internet, the intranet, groupwares, video conferences, among others, increase the opportunities for people to meet and develop new knowledge, breaking the traditional barriers generated by departmental 'barriers', arising from the organizational structure (Mohamed et al., 2006).

Bansler & Havn (2004) point out that success in the application of these technologies depends on the expansion of the repository of knowledge and on the improvement of individual skills, for expanding the knowledge base of the organization is only made possible through the training of employees. In addition, a wide opening of the company's knowledge base depends on employees who are able to interpret this knowledge, as well as to apply it in situations that generate an increase in performance. Gonzalez & Martins (2014) and Xue et al. (2011) add to this discussion by explaining that it is up to professional experts knowing how to analyze, select and define what information are useful for, otherwise, the knowledge base becomes a mass of data and information with little value to the organization. This theoretical discussion gives way to the fifth set of hypotheses:

> H5a. IT systems are positively related to innovation through knowledge exploration.
>
> H5b. IT systems are positively related to innovation through knowledge exploitation.

Figure 1 summarizes the model treated empirically in the next section. The Annex A identifies 18 items of measure, laid out based on the contextual factors, called exogenous or independent variables, and six measure items, laid out based on the practice of innovation through knowledge exploration and exploitation, known as endogenous or dependent variables.

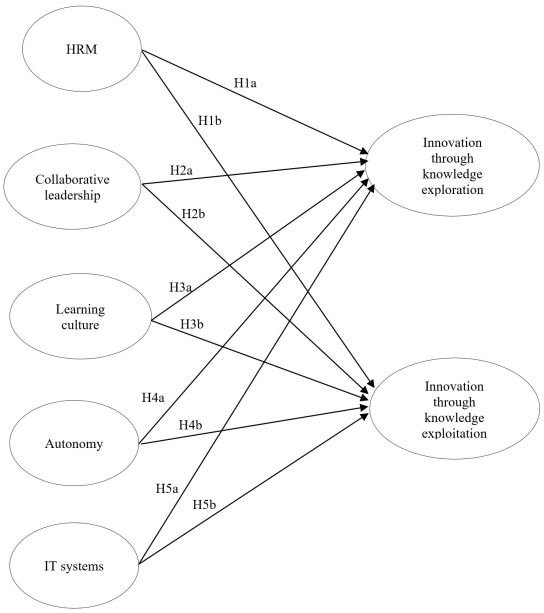

Figure 1. Research model.

4 Research method

4.1 Data collection

This study uses the collection of primary data in order to perform an empirical analysis that allows classifying the automobile industry's companies regarding the practice of KM and its implications in relation to innovation from knowledge exploitation and exploration. The research questionnaire was made up of two parts. The first deals with issues that characterize the company and the employee, and the second refers to the five constructs addressed in this research, as seen in the Annex A.

Initially, a pilot study was conducted with 12 professionals, graduated in the fields of Administration and Engineering, working in companies from the mechanic metal industry. They answered the initial questionnaire and provided comments during an individual meeting with the researcher via Skype. Based on the feedback from this step, the questionnaire was redesigned to improve its understanding and logical sequence, four questions were rewritten, one was removed, and two other were added.

The study was conducted in the Brazilian automotive industry. A total of 250 questionnaires were sent via email to management-level staff in the areas of production, human resources and engineering of companies registered in the National Association of Brazilian Auto Parts Manufacturers (SINDIPEÇAS), from September 2016 to December 2016. Along with the questionnaire, a letter of invitation was sent, in which the researcher elucidates the interest and importance of the survey. A total of 82 (32.80%) questionnaires returned, of which 4 were excluded due to problems with how they were filled. Therefore, the survey covered a total of 78 valid questionnaires, representing a return rate of 31,20%.

4.2 Measures

The measure variables or items of the contextual factors studied (Annex A) are calculated based on a six-point Likert scale, where 1 means "never practiced or total disagreement" and 6 means "always practiced

or total agreement." The measure of Cronbach's alpha is used to estimate the reliability of the measure items. As shown below, all items showed an acceptable level of reliability, since α exceeded the value of 0.7 (Hair et al., 2013). The development of the measure items was based on the following studies:

- HRM (α = 0.873): measurement items adapted from the work of Figueiredo et al. (2016) and Bontis & Serenko (2007);
- Collaborative leadership (α = 0.841): measurement items adapted from the work of Donate & Guadamillas (2011);
- Learning Culture (α = 0.885): measurement items adapted from the work of Ma et al. (2014);
- Autonomy (α = 0.770): measurement items adapted from the work of Lee and Choi (2003);
- IT systems (α = 0.793): measurement items adapted from the work of Xue et al. (2011);
- Practices of knowledge exploration (α = 0.766): measurement items adapted from the work of Donate & Guadamillas (2011);
- Practices of knowledge exploitation (α = 0.812): measurement items adapted from the work of Donate & Guadamillas (2011).

4.3 Data analysis

In the literature, the modeling of the structural equation based on the LISREL model is well-known and widespread. However, this procedure is not well-suited to treat smaller samples, as in the case of this survey (Hair et al., 2013). In order to avoid some limitations of the LISREL model, an alternative is the causal modeling technique based on partial least squares (PLS). In contrast to the LISREL model, the management field, including studies in the area of organizational learning, intellectual capital and knowledge management, offers adherence and good results based on the PLS technique (Hair et al., 2013).

According to Hair et al. (2013), the process of defining of the model starts based on the theoretical framework on the subject. Next, three evaluations that are relevant to the application of the PLS technique in the context of management research should be considered: the evaluation of the measures of reliability and convergent and discriminant validity, the determination of the relationship between the items (variables) and constructs, and finally, the interpreting of the path coefficients and general suitability of the model.

Initially, the reliability and convergent and discriminant validity of the factors was analyzed through confirmatory factor analysis (CFA). The values of construct reliability (CR) greater than 0.70 and Cronbach's α above 0.70 indicate that the constructs have acceptable levels of reliability. A CR greater than 0.70 and the factorial charges of the measure items having values above 0.50 in what concerns their respective factor points to the existence of convergent validity (Hair et al., 2013). Discriminant validity is verified through the average variance extracted (AVE). When the AVE values of the factors are greater than 0.50, the discriminant validity is accepted (Hair et al., 2013). In addition, the discriminant validity is also verified through the matrix that shows the AVE's square root and the correlations between the factors. When the square root of a particular factor's AVE is higher than the other correlations, discriminant validity is verified (Hair et al., 2013). SmartPLS version 3.0 was used to evaluate the measures and structural model of this research.

5 Results

5.1 Characterization of researched companies and respondents

The first analysis shows the demography of the researched companies. All the companies considered by the survey are medium or large, with the vast majority of them having between 500 and 5000 employees (46%), 41% of companies have between 100 and 500 employees and 13% of companies have more than 5000 employees. Regarding the origin of capital, 61.54% of the researched companies have national capital, and 38.46% are multinational. In relation to the position within the automotive supply chain, the survey covered 7.70% of automakers, 33.33% of strategic suppliers, i.e., they act directly in the automaker's product development process, and 58.97% of non-strategic suppliers, which only act in the supply of parts and components, and do not act directly with the automakers in the product development process.

Regarding the time the companies performed in the automobile market, the study considered companies with at least 5 years in the market. The data show that the high concentration of companies with a time of operation between 10 and 20 years (33%) and with more than 40 years in the market (32%). The number of companies with time between 5 and 10 years was small with about 7.7%.

The study of contextual factors of the organization requires that the respondent has a more in-depth view of the organizational context. Thus, the hierarchical

levels of management and supervision were considered, positions that have decision making power. The data collected indicate that most of the respondents are managerial (53%), 25% are supervisors and 22% are directors.

5.2 Convergent and discriminant validity

To assess the reliability of the factors, this study uses the Cronbach's alpha and construct reliability (CR) measures. All Cronbach's alpha values were acceptable, i.e., greater than 0.70, as indicated in the previous section. The values of CR and factor loading are shown in Table 1. The CR values of the constructs are greater than 0.70, indicating convergent validity, i.e., the variables that constitute the constructs display common variance. In addition, the factor loading of the items over their constructs is greater than 0.60 and the AVE values are greater than 0.50.

The average variance extracted values (AVE) of the constructs points to the existence of discriminant validity, i.e., the constructs are distinct from each other. In Table 2, the off-diagonal values correspond to correlations between constructs, and the diagonal refers to the square root of the AVE values of each construct. It is possible to notice that the square root values of the AVEs for each construct are greater than the correlation with the other constructs, indicating the existence of discriminant validity.

5.3 Structural model

The Goodness of Fit (GoF) index and R^2 measure of the endogenous (dependent) variables validate the PLS **model**, evaluating the consistency of the measures and of the structural model. GoF is used to determine the global prevision power of the model, considering the parameters of the measures scale and of the structure (Hair et al., 2013). The GoF found for this study's model is 0.38, exceeding the cutting value of 0.290 for large R^2 effects suggested by Hair et al. (2013), pointing out the great explanatory power of the model.

The path coefficients in the PLS model are similar to the β coefficients of the regression analysis (Hair et al., 2013). Figure 2 and Table 3 presents the results of the structural model. The R^2 value was 0.387 and 0.425 for innovation through knowledge exploration and exploitation, respectively, suggesting that 38.7% of the variance of innovation through knowledge exploration and 42.5% of the variance of innovation through knowledge exploitation can be explained by the five contextual factors included in the study.

Table 1. Reliability and convergent validity.

Factor	Item	Factor loading	CR	AVE
HRM	HRM1	0.811	0.818	0.733
	HRM2	0.735		
	HRM3	0.793		
	HRM4	0.856		
	HRM5	0.837		
Collaborative leadership (CL)	CL1	0.745	0.765	0.708
	CL2	0.780		
	CL3	0.733		
Learning culture (LC)	LC1	0.818	0.823	0.756
	LC2	0.844		
	LC3	0.863		
	LC4	0.771		
Autonomy (Aut)	Aut1	0.749	0.750	0.680
	Aut2	0.784		
	Aut3	0.832		
IT systems (IT)	IT1	0.820	0.783	0.688
	IT2	0.754		
	IT3	0.776		
Knowledge exploration practices (Expl)	Expl1	0.766	0.771	0.673
	Expl2	0.815		
	Expl3	0.785		
Knowledge exploitation practices (Expt)	Expt1	0.728	0.738	0.615
	Expt2	0.765		
	Expt2	0.792		

Table 2. Discriminant validity.

Factor	HRM	CL	LC	Aut	IT	Expl	Expt
HRM	0.856						
CL	0.165	0.841					
LC	0.183	0.318	0.869				
Aut	0.156	0.336	0.246	0.846			
IT	0.121	0.084	0.127	0.075	0.829		
Expl	0.188	0.144	0.180	0.263	0.147	0.820	
Expt	0.175	0.163	0.193	0.215	0.249	0.331	0.784

Note: The elements of the diagonal cells refer to the square root of AVE.

Table 3. Evaluation of the structural model.

Path	Path coefficient	t-value	Result
H1a: HRM →Exploration	0.161*	1.592	Accepted
H1b: HRM →Exploitation	0.255**	3.586	Accepted
H2a: Collaborative leadership →Exploration	0.123	1.269	Rejected
H2b: Collaborative leadership →Exploitation	0.233**	3.331	Accepted
H3a: Learning culture →Exploration	0.358***	5.363	Accepted
H3b: Learning culture →Exploitation	0.305***	4.011	Accepted
H4a: Autonomy →Exploration	0.321***	4.380	Accepted
H4b: Autonomy →Exploitation	0.093	1.391	Rejected
H5a: IT →Exploration	0.388***	16.011	Accepted
H5b: IT →Exploitation	0.166*	1.648	Accepted

Note: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

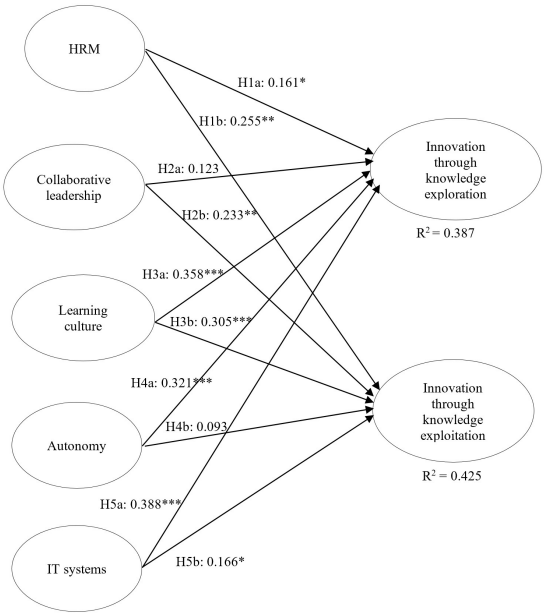

Figure 2. Structural model testing. Note: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

6 Discussion

This study analyzed the following issue: how do the contextual factors of the organization relate to innovation from knowledge exploration and exploitation? The research model is based on the three constructs associated with the organizational context, also called critical factors for the success of KM: people, organization and IT (Gonzalez & Martins, 2014; Gold et al., 2001). The research encompassed a total of 78 companies of the automotive industry and the model explains 38.7% and 42.5% of the variance of innovation through knowledge exploitation and exploration, respectively.

This research provides new evidence that HRM, leadership, culture, autonomy and IT systems have influence over the processes of innovation from the knowledge exploration or exploitation. In line with previous studies, this article offers more evidence that organizational conditions associated with the aforementioned factors interfere in organizational innovation (Ho, 2009; Miller et al., 2007; Donate & Guadamillas, 2011). However, few studies evaluate the relationship between these organizational conditions and procedures of knowledge exploration and exploitation. Another contribution this research offers is the mapping of clusters in relation to the development of these contextual factors.

This study is based on previous work which state that the practices of knowledge exploration and exploitation are guided by organizational values focused on the management and development of human resources (Figueiredo et al., 2016; Zangiski et al., 2013; Bontis & Serenko, 2007), collaborative leadership practices

(Analoui et al., 2012; Politis, 2001), learning culture (Donate & Guadamillas, 2011; Ma et al., 2014), autonomy (Lee & Choi, 2003; Ho et al., 2014) and IT systems (Bansler & Havn, 2004; Xue et al., 2011). Other studies also claim that organizational factors are essential elements to facilitate the implementation of KM strategies (Zack et al., 2009; Gonzalez & Martins, 2014; Donate & Guadamillas, 2011). Another important assumption of this work concerns the results of Gupta et al. (2006), Crossan et al. (1999), Levinthal & March (1993) and March (1991) who conceptualize organizational innovation as a mix between the processes of knowledge exploration and exploitation. March (1991) considers that exploitation consists of the refinement and extension of the organization's competences, paradigms and technologies, and Gupta et al. (2006) discuss this further in stating that both knowledge exploration and exploitation are innovation processes, and the difference between the two is the extent or type of innovation.

In relation to the factors included in the structural model, it may be noted that learning culture is the factor with the greatest impact in relation to the processes of knowledge exploration and exploitation ($\beta = 0.358$ and $\beta = 0.305$, respectively). As previous works suggest, an organizational culture with values geared towards learning and sharing of knowledge can be considered one of the main catalysts of innovation processes based on knowledge exploration and exploitation (Gold et al., 2001). The organizational culture that sustains KM is characterized by a state of mutual trust and identification of individuals in relation to the working groups and the organization itself, sustaining the flow and, consequently, the transformation of knowledge. These results are also in line with Corfield & Paton (2016) and Lin (2014) who state that the presence of assumptions of a learning culture eliminates focuses of resistance to change and to the implementation of KM initiatives itself. Learning-oriented culture, therefore, creates an environment that stimulates the proposition and sharing of ideas, leveraging new innovation opportunities.

With the exception of the learning culture factor, other factors showed bigger differences in what concerns the levels of significance or acceptance of the hypothesis test when compared to the processes of knowledge exploration and exploitation. HRM was significantly and positively related to the exploration and exploitation processes ($\beta = 0.161$ and $\beta = 0.255$, respectively). This result shows that HRM practices are more positively related to knowledge exploitation than to knowledge exploration. This result can be explained by the fact that for an organization to reach a higher level of innovation through the knowledge exploration, it needs to develop HRM practices that are different from those used in relation to exploitation, such as training and development of problem-solving methods and incentives and awards for work in groups, targeting incremental improvements. The knowledge exploration is more dependent on HRM actions aimed at employee exchanges between units that are internal and external to the organization (Bontis & Serenko, 2007), formation of communities of practices (Zárraga & Bonache, 2005) and training courses on new technologies for qualifying employees (Lefebvre et al., 2016).

Hypothesis H2, which verified the impact of collaborative leadership on the processes of exploration and exploitation, was accepted only for the knowledge exploitation ($\beta = 0.233$), and, separately, hypothesis H3, which assessed the relationship between autonomy and the processes of knowledge exploration and exploitation, was accepted only for exploration ($\beta = 0.321$). These results fill gaps from previous studies that assess the impact of leadership and autonomy on innovation, KM or use of knowledge without distinguishing the isolated impact on the processes of knowledge exploration and exploitation. Von Krogh et al. (2011) state that leaders assume a key role in establishing policies and organizational infrastructure that enhance and facilitate the flow of knowledge and KM. Leaders are also responsible for implementing practices of HRM focused on retention and dissemination of lessons learned and better practices (Bollinger & Smith, 2001). Davenport et al. (1998) also highlight the role of leadership in the development of a culture that encourages the sharing of knowledge among employees. The contributions of these three studies, geared towards the retention and dissemination of lessons learned, the encouraging to the flow of knowledge between employees and development of infrastructure for KM, show that collaborative leadership practices support effectively the process of knowledge exploitation, since these practices are focused on the refinement and improvement of the same primary knowledge base, while exploration requires actions geared towards research, discovery and development of new knowledge (March, 1991).

These considerations oppose the result verified for autonomy. As exploration requires the breaking of paradigms and researching of new technologies, the autonomy for employees to implement and develop new knowledge becomes essential in the process of knowledge exploitation. Separately, the exploitation of the same primary knowledge base does not require a high level of autonomy, because the changes in processes and products are not radical.

Finally, the structural model pointed out that both knowledge exploration (β = 0.388) and exploitation (β = 0.166) were significantly and positively related to the use of IT systems. The effective use of IT systems supports the process of retention and coding of explicit knowledge, facilitating its dissemination and exploitation. IT systems also allow individuals of different functional areas and organizational units to be integrated and connected, facilitating the exchange of knowledge and information. In addition, IT also supports knowledge exploration through the formation of practice communities, which connect individuals from different areas of the organization with research centers, universities, suppliers, and clients (Zárraga & Bonache, 2005). In this way, the use of IT acts as a facilitator in the processes of formalization, which is positively related to knowledge exploitation, and also to functional integration and to the integration between teams and functional areas, that have the most significant impact concerning knowledge exploration.

7 Conclusion

This study presents empirical evidence of the impact of five contextual factors of the organization (HRM, collaborative leadership, learning culture, autonomy and IT systems) in relation to the practice of innovation through knowledge exploration and exploitation. The results of the structural model show that exploration and knowledge is more impacted by the use of IT systems, autonomy and learning culture. Exploitation of knowledge, on the other hand, is more related to the learning culture and collaborative leadership. HRM showed intermediate levels of impact in relation to both processes. It also stands out that collaborative leadership does not have influence over the knowledge exploration and autonomy has no impact on the knowledge exploitation.

Although this study presents satisfactory results, it is possible to identify some limitations that need to be evaluated in future studies. Firstly, although a substantial portion of the variance relative to knowledge exploration and exploitation can be explained by the model, the explanatory power can be improved. Other variables, in particular those associated with the organizational sphere, such as leadership style, management support, organizational atmosphere, awarding, may be included in the model.

Secondly, although the research instrument has undergone a pilot test, the data collection method can generate errors, since it uses interviews carried out without the presence of the researcher. Thirdly, our conceptual model does not consider the specificity, complexity, and characteristics of the companies. To overcome this limitation, future research may consider organizational characteristics such as size, capital type, location etc. Fourthly, using the automotive industry as object of study may limit the generalization of the results to other contexts. Further study is required to assess to what extent the results of this study are applicable to various industries.

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Annex A. Measurement items.

Human resource management (HRM)

HRM1. The company's selection process considers the alignment between the skills and knowledge of the employee and the company's core competencies.

HRM2. There is a structured and systematic process for evaluating the skills of employees.

HRM3. The company provides training to employees in order to solve the shortcomings noted in their evaluation.

HRM4. The company offers possibility of professional growth, based on the employee's performance.

HRM5. Employees are rewarded and recognized for achievements.

Collaborative leadership (CL)

CL1. Leadership creates an environment that promotes teamwork.

CL2. Managers take on the role of knowledge leaders, guiding their subordinates in relation to better practices that promote the meeting of goals and objectives.

CL3. Managers act as advisers and control mechanisms are used to evaluate the achievement of goals and objectives.

Learning culture (LC)

LC1. Employees share ideas, knowledge and skills related to processes which they are part of.

LC2. During group activities, employees are encouraged to share experiences and lessons learned.

LC3. Employees are encouraged to explore new opportunities.

LC4 The company interprets any errors committed by employees in improvement activities as part of the learning process.

Autonomy (Aut)

Aut1. The employees of the working groups have the capacity to self-manage, i.e., self-organization capacity.

Aut2. Employees have the power to make decisions related to daily work, problem solving and improvement initiatives.

Aut3. Employees participate in the process of planning and defining of goals and objectives pertaining to their field of operation.

IT systems (IT)

IT1. IT systems facilitate the distribution and retention of the knowledge acquired.

IT2. When an improvement is planned by a team, individuals seek information in the informational systems.

IT3. Employees use IT systems in order to communicate with other individuals from within and outside the organization in order to share knowledge and ideas.

Annex A. Continued...

Knowledge exploration practices (Expl)

Expl1. Employees use their knowledge and skills in incremental improvement activities and problem-solving.

Expl2. Employees use their knowledge and skills in order to solve problems.

Expl3. The company presents a program of ideas and suggestions of employees to promote incremental improvements in processes.

Knowledge exploitation practices (Expt)

Expt1. The company can easily access new technologies through, for example, partnerships with other companies, universities, consulting offices etc.

Expt2. The company invests in the research and development of new technologies to improve or develop products/processes.

Expt3. The company can easily introduce new technologies into its processes or products without any great resistance to change.