Organizational learning capability and open innovation

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Abstract

Purpose: The purpose of this paper is to investigate the relationship between open innovation and radical and incremental innovation success in knowledge based companies. The company's human resources and organizational learning capability are considered as the fundamental nexus of this relationship.

Design/Methodology/Focus: At the conceptual level, the article analyzes the relationships between dynamic capabilities and open innovation and between open innovation and innovation success. Fuzzy-set qualitative comparative analysis (fsQCA) was used to study how innovation is implemented in 29 companies.

Findings: FsQCA identifies combinations of factors that facilitate incremental innovations. These combinations reveal the path to implementing company policies that enable incremental innovation and foster radical innovation.

Limitations/Implications of the Research: The nature of the study sample means that the findings should be generalized with precaution. The most valuable implication is the identification of combinations of factors that help companies manage innovation.

Originality/Value: Scarce literature links organizational learning factors and open innovation to different types of innovation. The use of fsQCA to analyze the cases also marks a breakthrough in the innovation literature.

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1. Introduction

In companies characterized by competitiveness and the ability to adapt quickly to changes in the environment, linking human resource policies to different forms of open innovation seems inevitable. These links develop naturally because companies that renew their capabilities efficiently also acquire knowledge, know-how, and new ideas that stem not only from their own experience, organizational routines (Nelson and Winter, 1982), and ordinary capabilities (Teece, 2014a), but also from the environment, competitors, partners, and related companies. This process has strategic relevance and must be managed and nurtured by developing dynamic capabilities (Teece, 2012, 2014a, 2014b; Winter *et al*., 2007; Zollo and Winter, 2002). The depiction of routines by Nelson and Winter (1982) shows how routines support and maintain the company's activity while tending to conserve and reiterate the techniques, procedures, and behaviors that the company employs. Accordingly, other routines or high-level strategic actions are required to allow the company to change and prosper through other forms of thought and innovation. Efforts to collaborate with other companies in innovation can considerably boost organizational learning capability and thereby affect all types of innovation within the company (Walker et al., 2013).

To build the theoretical framework, we first briefly explain the resource-based view (RBV), highlighting the two characteristics that made this approach effective and original in the early 1990s (Barney, 1991). The first characteristic is the company's idiosyncratic mixture of resources that together form an inextricable bundle. The second characteristic, which is a consequence of this bundle, is the causal ambiguity that surrounds the company's capabilities, making these capabilities inimitable and preserving the company's competitive advantage. Nevertheless, the RBV omits the explanation of change and evolution in these capabilities. In an economy characterized by brusque changes in the environment, R&D, and, consequently, innovation, creating an idiosyncratic mixture and maintaining a competitive advantage over the short term is not enough. This mixture of capabilities must be dynamic to preserve the company's competitive advantage over time (Teece and Pisano, 1994; Teece, 2012; Teece, 2014a). This need for a dynamic mixture of capabilities gives rise to the dynamic capabilities view (DCV). Both approaches, RBV and DCV, enable study of the creation of knowledge and know-how in companies. They also provide a deeper understanding of the routines associated with innovation as per Nonaka's model (Nonaka, 1994; Nonaka & Takeuchi, 1995).

The second part of the theoretical framework links dynamic capabilities to open innovation and organizational learning factors. This part of the literature review discusses the fact that high-level routines or company strategy must assess the convenience of obtaining innovation through a mix of internal and external sources and determine how to organize innovation-related capabilities within the organization (Dahlander and Gann, 2010; Teece, 2014a). A key issue is whether innovation capabilities can be the object of simple acquisitions, whereby other companies freely reveal or sell their technologies, or whether close cooperation with external agents and complex integration of external technology or knowledge in the company's products and processes are necessary. If this close cooperation and integration is in fact necessary, the organizational and cultural foundations that underlie innovation processes represents a major factor to open innovation (Van de Vrande *et al*. 2009). Moreover, a common culture may develop among companies from the same industry, network, or community of practice. This common culture facilitates open innovation (Brown and Duguid, 2000; Hao *et al.*, 2017).

Human resources play a central role in open innovation (Escriba-Carda, 2017; Huselid, 1995; Huselid and Becker, 2011; Nonaka and Konno, 1998; Nyberg *et al*., 2014). The qualified employees who intervene in the innovation process, from all levels and specialties, are those who must incorporate external knowledge into the organizational learning capability of the company.

The article has five parts. First, the relations between capabilities and dynamic capabilities are established (Section 2). Second, organizational learning capability is linked to open innovation and the hypotheses are formulated (Section 3). Third, in Section 4, we present the cases and the data from the empirical study (Section 4.1) and the analysis of the study and its findings (Section 4.2). Finally, we end with a summary of the conclusions (Section 5).

2. Capabilities and dynamic capabilities

The company's production, marketing, and R&D capabilities and skills to compete have been addressed under numerous management approaches. Andrews (1971) established this variety of approaches in his SWOT analysis. Nevertheless, in the search for competitive advantage, researchers and practitioners have tended to focus on either internal capabilities or the environment, with numerous scholars applying a range of approaches. Porter's approach in the 1980s (Porter 1979, 1980, 1985, 1990) led to detailed analysis of the conditions within the industry and among competitors, with less emphasis on strengths and internal capabilities. Although greater attention was generally paid to the environment and competition during this period, Wernerfelt (1984) inquired why companies in the same industry that rely on the same resources—often even adopting the same strategy—perform differently. The answer, which is the result of research by numerous scholars in the 1990s, is that each company possesses and manages different resources and capabilities (Amit and Schoemaker, 1993; Barney, 1991, 2001; Grant, 1991, 1995; Peteraf, 1993).

Companies in the same industry that can acquire the same resources do not manage and combine these resources in the same way. In the most competitive industries, this mixture of resources is unique for each company, and the combination and integration of the specific tangible and intangible resources gives rises to what is referred to in the literature as causal ambiguity. Verifying the cause of a specific company's competitive advantage is impossible because the bundle of resources acts as a whole (Mahoney and Pandian, 1992; Peteraf, 1993). Consequently, the competitive advantage may be sustainable because competitors cannot imitate the company without acquiring the whole bundle of resources and managing these resources in the same way (Barney, 1991). Wernerfelt (1984) named this approach the RBV.

A deeper understanding of sustainable competitive advantage nonetheless requires consideration of the company's dynamic environment. Changes in available resources, consumer tastes, and technology (Zahra *et al*., 2014) make the capacity to adapt the company's most valuable capability. The unsurpassable value of being able to adapt, is the key principle of the DCV (Denford, 2013; Helfat *et al*., 2007; Helfat and Peteraf, 2015; Kinström *et al*., 2013; Li and Liu, 2014; Makkonen *et al*., 2014; Mckelvie and Davidsson, 2009; Schilke, 2014; Teece, 2007, 2014a; Teece and Pisano, 1994; Zheng *et al*., 2011). Teece *et al*. (1997, p. 515) defined dynamic capabilities as "the firm's ability to integrate, build upon and reconfigure internal and external resources and functional competences to deal with environments which are constantly evolving." Changes in the environment may be a consequence of dynamism in companies' capabilities and the materialization of these capabilities in strategic innovations and products. Likewise, environmental changes related to sustainability, technology, and consumer tastes stimulate the creation of new combinations of resources.

Teece's (2007) and Helfat and Peteraf's (2015) recommendation regarding the foundation of sustainable enterprises is based on studies by Grant (1996a, 1996b, 2001). Grant argued that one of the company's fundamental resources is the way knowledge is generated by employees at all levels within the organization. This knowledge creation is even more important in highly qualified and/or creative jobs. Knowledge is deposited in individuals, groups, and the organization—always people, individuals, or groups—that sustain and create the culture, skills, and know-how of a company. This view is emphasized by the perspectives of intellectual capital (Bontis, 2001; Dolfsma and Van der Eijk, 2017; Huseman and Goodman, 2014; Vargas and Lloria, 2017) and social capital (Sreedhar and Shelby, 2017). Thus, according to Huselid (1995), everything depends on human resources, including both the idiosyncratic and dynamic mixture of DCV as well as innovations that result from open innovation procedures. This view is nothing new. It can be found in classic works, albeit in a less systematic and less developed form. For instance, Barnard (1938) considered the importance of the human element in all of his studies, especially in *The functions of the executive*, and Ouchi (1980) used the degree of socialization as an essential element to explain the forms or types of organization. Consistent with classic works, Nonaka focused on the cultural climate of the organization, the level of socialization, and the shared objectives and existence of a common culture (Nonaka and Konno, 1998; Nonaka et al., 2000). As in Nonaka's model, theoretical analysis of open innovation from an inner organizational perspective is based on knowledge flow (Enkel et al., 2009). For example, organizational learning, which is the process whereby organizations acquire and integrate new knowledge (Jimenez-Jimenez and Sanz-Valle, 2011), is the key driver of the firm's capacity to adapt and innovate (Garcia-Morales et al., 2011; Soriano and Peris-Ortiz, 2011). The key factors that sustain a company's organizational learning capability moderate the effectiveness of open innovation (Dolfsma and Van der Eijk, 2017) and therefore overall innovation performance.

A key element in all the above theories is human resources (Huselid, 1995; Huselid and Becker, 2011), namely the people who provide the capability and performance to achieve objectives. Human resources are at the heart of the relationship between the *organizational learning capability* and *open innovation*. This idea is reflected in the hypotheses formulated in the next section.

3. Organizational learning capability and open innovation

In the open innovation literature, firms are depicted as seeking paths to access the knowledge and know-how that they lack—or possess only partially—within the organization and that, because of issues related to time, costs, or minimization of risks, companies prefer not to develop internally (Cheng and Huizingh, 2014; Chesbrough *et al*., 2008). Generally, "Internal capabilities and external relations are (…) complements rather than substitutes. Firms spent considerable times and resources on internal R&D, and this leads to the question of what is the right balance between internal and external resources of innovation" (Dahlander and Gann, 2010, p. 701). This observation is important because the internal capabilities of innovation are reinforced when supported by other agents, and this support requires a balance between internal and external capabilities (Helfat, 2006; Soriano et al., 2014).

In most open innovation cases, external and internal capabilities interact. The type of openness ranges from situations where this interaction plays a minor role or may even be non-existent to situations that require close cooperation between two parties. According to Dahlander and Gann (2010, pp. 703–704), situations where interaction is minor are what the authors call "outbound innovation–non-pecuniary" and "outbound innovation–pecuniary." Outbound innovation–non-pecuniary refers to companies that reveal some of their technologies to aid collaboration with other companies, although without guaranteeing that this will occur. Revealing these technologies generates a greater range of forms and possibilities of cooperation and provides a source of innovation in other companies where there may be no interaction between those who develop technology and those who internalize the technology. Outbound innovation–pecuniary corresponds to firms whose research generates technological spillovers that they wish to market. In this case, through negotiation and agreement, these firms acquire the technology—or specific parts thereof—and, where required, establish corresponding forms of interaction and cooperation. Nevertheless, the challenges that relate to the organizational and cultural issues that underlie the company's way of acting can hinder open innovation (Van de Vrande *et al*., 2009). Some forms of innovation occur jointly between different teams of companies that have the common culture of a specific industrial or technological sector or that belonging to the same community of practice and belong to the same dense network of interactions (Scott and Brown, 1999; Brown and Duguid, 2000).

At the heart of the open innovation model is the issue of how the firm develops, integrates, and uses ideas and external knowledge to innovate (Laursen and Salter, 2006). Qualified employees who intervene in the innovation process enable the inclusion of new external knowledge within the dynamic capabilities of the company. This process depends on the capabilities and behavior of the company's human resources. Here, the company's proactive policy, routines, and systems that foster the incorporation of external knowledge are crucial.

The current literature focuses on learning processes and knowledge management systems as key elements to implement open innovation successfully. Knowledge management systems help in exploiting internal and external flows of knowledge through the development of dynamic capabilities such as learning capabilities. In turn, these dynamic capabilities increase innovation capacity (Santoro et al., 2017). The importance of external relationships in innovation is highlighted by Ferraris et al., (2017), who focus on the subsidiary organizational level of multinational companies. Subsidiaries interact with providers and clients, gaining access to unique knowledge that must be incorporated into the company while gaining access to the company's knowledge repositories. Managers must actively build knowledge management tools and processes for knowledge transfer and sharing to increase the subsidiary's effective use of external R&D. Doing so can augment the magnitude of external sources of knowledge and, consequently, improve innovation performance. As Martinez-Conesa et al. (2017) showed, commitment-based human resource practices have a significant positive influence on knowledge management capability, and knowledge management capability has a significant positive influence on open innovation.

Studies that have examined the antecedents of open innovation from a capability-based framework consider managing internal and external knowledge to be the most important capability (Lichtenthaler and Lichtenthaler 2009). When addressing dynamic capabilities that relate to innovation, the DCV literature contains numerous examples of how the use of organizational learning capability acts as an antecedent of innovation (Akgün et al., 2007). Knowledge management and organizational learning constructs share basic concepts (Chiva and Alegre, 2005). Organizational learning capability can be defined as a process for acquiring, sharing, distributing, and using knowledge (Imamoglu et al., 2015). Nevertheless, the operationalization of organizational learning capability has generally focused on cultural and behavioral aspects rather than systems, procedures, and routines. For instance, Chiva et al. (2007) defined five dimensions of organizational learning: experimentation, risk-taking, interaction with the external environment, dialogue, and participative decision-making. Here, organizational learning is defined as a process where employees of the organization have the potential to affect the company's development of capabilities and behaviors using their common experiences as well as new knowledge (Fiol and Lyles 1985, Senge, 1990; Slater and Narver, 1995). Thus, organizational learning capability is heavily influenced by cultural issues, leadership style, decision-making, and risk and acceptance policies of the organization.

The critical factors for building organizational learning capability that moderate the effectiveness of open innovation can be grouped into four dimensions (Jerez-Gómez et al., 2005): managerial commitment, systems perspective (clear view of the objectives), openness and experimentation (both internal and external), and knowledge transfer (promoting dialog and debate among members of the organization). These factors are also discussed in the innovation literature. For instance, Ritter and Gemünden (2004) highlighted the importance of a business strategy with clear innovation objectives. Other authors, such as Pablo et al. (2007), found that leadership and trust are critical for creating an atmosphere for continual learning and new resource creation (Chakravarthym and Gargiulo, 1998). Managers' support and boundary-spanning leadership (Fleming and Waguespack, 2007), training of employees, clear strategic innovation objectives, innovation-related procedures that encourage experimentation and support risk-taking, and corporate culture regarding autonomy and participation in decision-making (West et al., 2006; Chiva et al., 2007) are usually considered together to examine the effect of organizational learning capability on innovation (García et al., 2007; Ussahawanitchakit, 2008). Our study, however, examined each factor individually and explored how these factors interact with one another to form the optimal combination for open innovation.

In the literature, it is usually assumed that employees involved in knowledge-sharing activities for open innovation are skilled and qualified. Consistent with the previously discussed theory, however, our study tested the need for participation from all employees (H6). We tested the following six hypotheses:

H1: Effective open innovation needs support and leadership from managers.

H2: The human resources that intervene in the open innovation process to aid innovation are highly qualified.

H3: Effective open innovation needs a clear set of objectives.

H4: Effective open innovation needs the support of clear innovation procedures.

H5: Employees in charge of open innovation must be granted trust and autonomy.

H6: Effective open innovation must involve all employees.

In the empirical study, we distinguished between open innovation outcomes based on the novelty— radical or incremental—of the resulting innovations.

4. Method and results

4.1. Sample and data

Obtaining data on all factors covered in this study was difficult, so a specific database was created to study 29 companies. Because our principal goal was theory development and refinement rather than theory testing, cross-case analysis was performed using fuzzy-set qualitative comparative analysis (fsQCA) (Huang and Roig-Tierno, 2016). Although effective use of QCA depends on the ratio of cases to causal conditions, 30 cases is considered sufficient for reliable fsQCA (Kent, 2008, p. 10). The companies were from Spain, France, and Portugal. They were selected because of their knowledge-based activities. The corporate sectors under study were engineering consulting (5 companies), software development (5 companies), e-commerce (5 companies), electricity (1 company), optical and precision equipment (2 companies), biotechnology (2 companies), auto (3 companies), entertainment and game development (2 companies) education (3 companies), and advertising and marketing (1 company). The respondents were the general manager or head of innovation. All but four companies were small or medium sized.

During the interviews, which took place between December 2016 and January 2017, seven factors (conditions) were assessed by respondents, with the help of the authors, using a 7-point Likert scale. Four outcomes were also assessed for each company using the same procedure. These outcomes were radical innovation in products and services, radical innovation in processes, incremental innovation in products and services, and incremental innovation in processes. Table 1 shows the conditions and outcomes and the correlations between them.

Table 1. Correlations between conditions and outcomes (innovations)

Conditions and outcomes	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
1. Innovation by highly qualified workers (HQ)										
2. Innovation based on open innovation (OI)	06									
3. Clear innovation objectives (IO)	.02	.37*								
4. Clear innovation procedures (IP)	-.20	.08	.21							
5. Autonomy of innovation employees (IME)	.29	-.03	-.02	-.63**						
6. Innovation led by managers (ML)	.18	.30	.66**	.01	.34					
7. Innovation includes all employees (AE)	.31	.29	.24	.30	.01	.29				
8. Radical innovation in products/services	.09	.57**	.12	-.35	.52**	.17	.11			
9. Radical innovation in processes	-.03	.65**	.72**	.22	-.11	.49**	.25	.33		
10. Incremental innovation in products/services	-.27	.00	-.28	-.35	.34	.01	-.38*	.15	-.13	
11. Incremental innovation in processes	.09	.59**	.45*	.29	-.13	.52**	.21	.28	.51**	-.15

* $p < 0.05$; ** $p < 0.01$ (two tailed)

The correlations in Table 1 imply that the conditions were independent. Only a few correlations were significantly correlated. Only innovation led by managers (ML) and innovation based on open innovation (OI) had significant direct individual effects ($p < .01$) on process innovations (radical and incremental). Most relationships between conditions and outcomes (for the four types of innovation) were completely hidden. If the theoretical framework indicates a clear effect of the conditions on the outcomes yet these relationships do not appear in the correlations analysis in Table 1, then the relationships may be causally complex and asymmetric. QCA is suitable for addressing this complexity because it enables detection of configurations (combinations of conditions) that are necessary or sufficient to cause an outcome (Woodside, 2013).

4.2. Analysis and results

To assess different configurations of the factors that encourage innovation, we used fsQCA. FsQCA is particularly useful in comparative case studies (Schneider and Wagemann, 2010). FsQCA is based on specific requirements on the core issues of research design. Such requirements include case selection, variable specification, and set membership calibration. The case study helps generate the data (concept formation and measurement) and allows for meaningful interpretation of the fsQCA results (Huang and Roig-Tierno, 2016).

When calibrating the variables, it is crucial to specify qualitative anchors (the set membership scores of 0, 0.5, and 1). Although a mechanical application of the statistical median or mean for the data is usually wrong when calibrating sets (Schneider and Wagemann, 2010), the mean, median, and standard deviation helped assess variation between cases. Nevertheless, each condition and outcome was examined individually and calibrated according to the authors' perceptions. The most extreme case occurred with incremental innovation, where full membership corresponded to scores of 7 on the 7-point Likert scale, the crossover point corresponded to scores of 6, and the anchor for full non-membership was just below 5.

The necessary conditions for the presence and absence of radical innovation appear in Table 2. Because no universally valid precise values exist for the consistency threshold, we adopted the commonly used value of 0.75 for analysis of sufficiency (Ragin 2008, p. 118). For necessary conditions, however, consistency should be higher (Schneider and Wagemann, 2006). A minimum value of 0.9 is generally accepted (Schneider *et al.*, 2010).

Table 2. Analysis of necessary conditions for radical innovation (RI)

	Output (RI in products/services)		Output (*RI in processes*)	
Conditions	*Consistency*	*Coverage*	*Consistency*	*Coverage*
Innovation by highly qualified workers	0.55	0.58	0.77	0.67
Innovation based on open innovation	0.85	0.83	0.84	0.68
Clear innovation objectives	0.86	0.72	0.64	0.45
Clear innovation procedures	0.45	0.56	0.41	0.42
Autonomy of innovation employees	0.82	0.85	0.77	0.66
Innovation led by managers	0.89	0.68	0.81	0.52
Innovation includes all employees	0.83	0.68	0.67	0.46

The consistency values in Table 2 show that only innovation led by managers has a consistency score close to 0.9 for radical innovation in products and services. Only innovation based on open innovation has a consistency score greater than 0.84 for both product and service innovation and process innovation. Thus, only innovation led by managers is a necessary condition for radical innovation. Like Table 2, Table 3 shows the necessary conditions for presence and absence of incremental innovation.

Table 3. Analysis of necessary conditions for incremental innovation (II)

	Output (II in products/services*)*		Output (*II in processes*)	
Conditions	*Consistency*	*Coverage*	*Consistency*	*Coverage*
Innovation by highly qualified workers	0.56	0.71	0.63	0.81
Innovation based on open innovation	0.69	0.81	0.65	0.77
Clear innovation objectives	0.90	0.91	0.82	0.84
Clear innovation procedures	0.56	0.83	0.57	0.86
Autonomy of innovation employees	0.59	0.73	0.64	0.81
Innovation led by managers	0.91	0.83	0.89	0.83
Innovation includes all employees	0.83	0.82	0.79	0.80

Strictly adhering to the threshold of 0.9 implies that only two conditions are necessary for incremental innovation, in both cases product and service innovation. These conditions are clear innovation objectives and innovation led by managers. There are no strictly necessary conditions for incremental innovation in processes, but innovation led by managers is noteworthy (consistency of 0.89).

The truth table of all possible logical combinations yields several consistent configurations for incremental product innovation. Tables 4 and 5 show the minimally sufficient configurations for incremental innovations in products and services and in processes, respectively. The coverage scores reflect the empirical relevance of each solution. The consistency scores reflect the degree to which cases sharing the same configuration share the same outcome (Ragin and Fiss, 2008). The reduction of rows was performed using the Quine–McCluskey algorithm.

Table 4. Antecedent configurations leading to incremental innovation in product/services (IIP&S)

Sol.	*Path*	*Raw coverage*	*Unique coverage*	*Consistency*
1	~HQ*~OI*~IO*~IP*~IME*~AE→ IIP&S	0.07	0.03	0.52
2	**HQ*IO*ML *OI*~IP*IME*~AE→ IIP**&S	**0.13**	**0.10**	**0.95**
3	**HQ**IO*ML*~OI*IP*~IME *AE→ IIP**&S	**0.19**	**0.17**	**1.00**
4	**~HQ*IO*ML*OI *IP *AE→ IIP**&S	**0.16**	**0.13**	**1.00**

Solution coverage: 0.47; Solution consistency: 0.87; outcome: incremental innovation in product/services.

The successful configurations (paths) for incremental innovations in products and services (Table 4), with consistency values greater than 0.75, are shown in only three cases (path 2, 3, and 4). Innovation led by managers (ML) and clear innovation objectives (IO) are necessary conditions in the three consistent paths. The remaining paths can be grouped into two types: those where innovation is based on highly qualified employees (paths 2 and 3), and those where innovation is based on all employees (paths 4). In the latter case, it is important for innovation success to rely on innovation procedures. Both paths 2 and 3 are based on highly qualified employees. Path 3 refers to large companies with R&D departments. For smaller firms (path 2), innovation is mostly based on highly qualified employees with strong external relationships in innovation (open innovation), and major autonomy is an alternative solution for incremental innovation in products and services.

Table 5 shows three consistent paths (2, 3, and 4) for incremental process innovations. The paths are identical for incremental product and service innovation. Path 3 belongs to large companies with research activities led by a small R&D department in terms of total number of employees. In path 2, innovation is the responsibility of highly qualified employees with autonomy and close relationships with suppliers, customers, and allied companies. The only difference in relation to Table 4 is that innovation by all employees (path 4) can be achieved internally, and ongoing, strong relationships with external agents are not necessary.

Table 5. Antecedent configurations leading to incremental innovation in processes

Sol.	*Path*	*Raw coverage*	*Unique coverage*	*Consistency*
1	~HQ*OI*~IO*~IP*~IA*~IME*~AE→ IIP	0.05	0.00	0.36
2	**HQ*IO*ML *OI *~IP*IME*~AE→ IIP**	**0.12**	**0.09**	**0.95**
3	**HQ*IO*ML *~OI *IP*~IME *AE→ IIP**	**0.19**	**0.16**	**1.00**
4	**~HQ*IO*ML *IP *AE→ IIP**	**0.15**	**0.12**	**0.96**

The truth tables of possible combinations for radical innovation in processes and in products and services reveal low consistencies (0.56 and 0.69, respectively; data not shown). While no clear conclusions can be drawn, two combinations nonetheless have high consistency (bigger than 0.9). The first configuration, leading to process innovation, consists of a combination of autonomous, highly qualified employees with strong external relationships in innovation, support from managers, and clear strategic objectives but without standardized innovation procedures. The same path appears for radical innovation in processes, including open innovation. The second combination is linked to companies with an R&D department.

Consequently, Hypothesis 1, that effective open innovation needs support and leadership from managers, is corroborated for radical innovations (in products and services and in processes) and for product and service incremental innovations because the variable "Innovation led by managers" is a necessary condition. Hypothesis 2, that the human resources that intervene in the open innovation process to aid innovation are highly qualified, is only partially corroborated for incremental innovation, as shown by paths 2 and 3 in Tables 4 and 5, where highly qualified work and employee participation are shown. Hypothesis 3, that effective open innovation needs a clear set of objectives, is corroborated because OI appears in all the consistent paths leading to incremental innovation. Hypothesis 4, that effective open innovation needs the support of clear innovation procedures, is partially corroborated, appearing in paths 3 and 4 for both incremental product and service innovation and incremental process innovation. Hypothesis 5, that employees in charge of open innovation must be granted trust and autonomy, is only partially corroborated because the variable "autonomy of innovation employees" only appears in path 2 in Tables 4 and 5. Hypothesis 6, that effective open innovation must involve all employees, is partially corroborated, appearing in paths 3 and 4 for both incremental product and service innovation and incremental process innovation.

5. Conclusions

The results yield several conclusions. First, there is a major difference between radical and incremental innovations. Incremental innovations are more easily managed. According to the empirical study, it is possible to guarantee their success if certain conditions are met. In contrast, no consistent paths lead to success in radical innovations. Nevertheless, some combinations are more consistent than others for these radical innovations. Policies and procedures in organizational learning and open innovation are crucial for radical innovation to occur, but their consistent effect is attenuated by the complexity and risk of radical innovation.

The second classification criterion (products and services vs. processes) reveals few differences in incremental innovations. The only difference is that when product service innovation is based on the participation of all employees, the innovation must be led by personnel with strong relations with suppliers, customers, or allied companies in innovation activities. Another interesting finding with respect to incremental innovation refers to innovation led by highly qualified employees. Two mutually exclusive forms of management lead to success. One is based on the condition that employees that are most closely linked to innovation have relations with external agents. In this case, it is counterproductive to manage innovation strictly. Instead, innovation management must be based on setting clear objectives and allowing professionals autonomy in relation to external agents. A lack of clearly defined procedures for innovation hinders the participation of all employees in this model. The other form of incremental innovation management is to implement and foster innovation procedures whereby innovation becomes a responsibility for all employees with an overall vision of all business functions. The third path is the formalization of the innovation processes with highly qualified employees through the R&D department. This successful path only applies to large companies where the R&D department is small in relation to the whole company. Nevertheless, the R&D department has the resources and support required to develop innovations in a strategically structured and planned way.

Finally, based on the results of the empirical study, hypotheses H1 and H3 are corroborated, albeit only for incremental innovation. Hypotheses 2, 4, 5, and 6 are only partially supported because there are alternative combinations of reliable policies relate to incremental innovation.

The findings of this study contribute to the literature in two ways. First, the results reveal clear differences between radical and incremental innovation. Although some policies can be implemented in both cases, a clear distinction between these two types of innovation would allow studies to provide deeper insight (Chesbrough and Crowther, 2006; Chiang and Hung, 2010; Laursen and Salter, 2006). Second, open innovation can be successfully managed internally in different ways. Although there has been considerable discussion regarding the different modes and mechanisms of open innovation from an external perspective, both outbound (out-licensing, spin-outs, corporate incubators, etc.) and inbound (scouting, crowdsourcing, intermediaries, etc.) (Chesbrough and Bogers, 2014; Michelino *et al.*, 2014), few studies have examined different types of open innovation from an internal perspective.

5.1. Managerial implications

The principal managerial implication of the study is that incremental innovation can be guaranteed if a certain set of conditions is established. In addition, several combinations of policies and procedures can provide a secure way of obtaining benefits from efforts and resources invested in innovation. Incremental innovation must always be based on a clear definition of the organization's innovation objectives and the managers' leadership. If innovation is based on all employees, however, then procedures and guidelines must be implemented. Otherwise, when innovation is led by highly qualified employees, they must be autonomous, and the innovation must be linked to external collaborations. Innovation based on a formal R&D department is also a viable option.

Radical innovation is too complex to be ensured by a combination of managerial activities and policies. Nevertheless, the support of top managers is necessary for radical innovations to emerge.

Another interesting finding relates to the differences between product and service innovations and process innovations, especially in terms of radical innovation. Radical innovation in processes does not require clear strategic objectives, and it is led by highly qualified workers. Nevertheless, in both cases (in product and service and in process), collaboration with external agents is a relevant condition.

5.2. Limitations and future research

This study examined a small number of cases. FsQCA is a qualitative method that is useful for exploratory research, and although we established the variables theoretically before conducting the empirical study, the combinations (paths) of effective innovation conditions were detected automatically by the fsQCA software. Nonetheless, the number of cases (29) was low given the number of variables (7) and the high number of possible combinations of conditions. Not all combinations of conditions were represented by actual cases, and highly interesting combinations were represented by only one or two cases. This limitation reduces the study's impact. Interactions between variables inside the organization were not considered. Basic information might thus have been neglected regarding feedback and incompatibility between conditions. Another limitation relates to the use of subjective perceptions to assess the conditions and outcomes. An important improvement would be to use objective indicators to measure innovation, although the presence of different industries would make the comparison between cases difficult.

Future research should overcome the aforementioned limitations. Based on the innovation paths presented in this study, a more thorough case study should be carried out, focusing on relationships and interactions between variables of each combination and the potential factors that affect the radical innovation activities. In reference to incremental innovations, a confirmatory quantitative study based on questionnaires could be applied to confirm the three successful paths to innovation identified in this study.

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