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A configurational approach to innovation performance: The role of creativity

Víctor del-Corte-Lora [a], Teresa Martínez-Fernández [a, *], Teresa Vallet-Bellmunt [a], Norat Roig-Tierno [b]

[a] Departament of Business Administration and Marketing, Universitat Jaume I, 12071, Castelló, Spain
[b] Department of Economy and Social Sciences, Universitat Politècnica de València, 46022, València, Spain

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ABSTRACT

In this study, we analyze new ways of conceptualizing improvements in firms' innovation by implementing the "right-factors configuration," illustrated through an analog of a recipe and its ingredients. Specifically, we research the multiple combinations of three ingredients (creativity, innovation networks, and resources) required to accomplish the innovation recipe. Using a sample of firms from a Spanish science and technology park, we apply qualitative comparative analysis (QCA)—specifically, fuzzy-set QCA (fsQCA)—to test the importance of each component in technological and non-technological innovation. First, the results suggest a map of combinations of innovative ingredients with eight possible patterns. Second, they show that the only ingredient needed is the combination of a creative climate and creative intensity. Finally, the methods of obtaining technological and non-technological innovations differ. The implications for management and policymakers are discussed, and directions for future research are highlighted.

1. Introduction

Innovation is at the heart of a company's core strategy (Ayalew et al., 2019). Following the Oslo Manual (OECD, 2005b), innovation involves the implementation of a new or significantly improved product (good or service) or process, a new marketing method, or a new organizational method in business practices, workplace organizations, or external relations. The Oslo Manual (OECD, 2005b) distinguishes between technological innovation (TI; in which technology is applied to create or improve new products, services, or processes) and non-technological innovation (NTI; in which the focus is on the organizational structure and marketing activities).

Innovation has always attracted academic interest, and three lines of research stand out in this regard. The first is the view of innovation as an input to improve business performance. This line of research examines how one or more types of innovation influence business performance. Some studies that present TI or NTI as an antecedent of economic, market, or financial performance are those of Mothe and Nguyen-Thi (2010), Gunday et al. (2011), and del Carpio Gallegos and Miralles (2021).

* Corresponding author.
E-mail address: tmartine@uji.es (T. Martínez-Fernández).

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The second stream is the dynamic perspective, which conceives innovation as a process with several stages requiring different resources and capabilities, with individual and organizational creativity being the key elements of innovation (Stojcic et al., 2018). An example is the dynamic componential model of creativity and innovation (Amabile and Pratt, 2016). The literature on innovation highlights creativity in the innovation process, wherein technological (Lee and Drever, 2013) and non-technological activities (Mothe and Nguyen-Thi, 2010) play a crucial role.

The third line of research considers innovation as an output. Firms possessing heterogeneous innovative resources can adopt different innovation paths to configure their innovation portfolio based on four strategies: product, process, organizational, and marketing innovation (Seclen-Luna et al., 2022) or by distinguishing between TI and NTI (Geldes et al., 2017; Mothe and Nguyen-Thi, 2010). Therefore, most research has been devoted to understanding how companies can stimulate and promote TI (Henao-García and Cardona Montoya, 2021). However, the recent advent of studies that consider NTI and the interrelation between the two kinds of innovation (González-Blanco et al., 2019) has generated considerable academic interest (Henao-García and Cardona Montoya, 2021). These relationships present two opposing visions: the distinctive view and the integrative view (González-Blanco et al., 2019), which cover the entire range of existing TI–NTI relationships (substitutability or complementarity).

However, determining the essential factors that affect firms' innovation performance remains an open question (Ayalew et al., 2019). Regarding TI and NTI, several authors have focused on only one input, such as cooperation (Geldes et al., 2017), technical and administrative human resources (Henao-García and Cardona Montoya, 2021), and different types of knowledge-intensive business services (KIBS; Seclen-Luna et al., 2022). Others have combined several inputs and analyzed their direct or indirect impacts on TI and NTI. For example, González-Blanco et al. (2019) and Mothe and Nguyen-Thi (2010) studied barriers, information sources, research and development (R&D) intensity, and legal protection on TI and NTI. Fufa (2020) analyzed the combination of cooperation and resources, and García Álvarez-Coque et al. (2017) investigated education, collaboration, resources invested in R&D, and resources invested in other activities.

However, little is known about how interactions among inputs foster or hinder TI and NTI. Moreover, most empirical studies on the determinants of innovation focus on large firms; therefore, empirical studies on small firms remain rare and scarce (Abdu and Jibir, 2018).

Based on this research gap, this study's general hypothesis is that the variables most commonly used in the measurement of innovation have different effects on the conditions for TI and NTI. The model has been applied to micro and small enterprises.

Our work focuses on the third line of research, in which innovation—TI and NTI—is an output. Innovation can be achieved by combining inputs or ingredients (Panigrahy and Pradhan, 2015). Three perspectives are noteworthy according to their predominant innovation ingredient:

1) The creativity perspective, in which creativity is the key ingredient of innovation (Çokpekin and Knudsen, 2012): Regarding the effect of creativity on innovation, previous research has investigated the factors related to the characteristics of a creative workforce, creative intensity (Chen and Huang, 2010), and creative climate that can affect innovation (Amabile, 1988). However, these factors were analyzed individually without considering the interactions between them.
2) The innovation network perspective, wherein many benefits are associated with the appearance and development of innovation networks: These benefits could include accessing external resources and an expanded knowledge base, exploring new opportunities, and developing the firm's core competencies (Corsaro et al., 2012). Within this range of actors, the relationships between the firm and other institutions are considered the main drivers of innovation processes (Molina-Morales et al., 2014; Molina-Morales and Martínez-Fernández, 2010; Parjanen, 2012). Supporting organizations such as universities or technology centers allows firms to develop innovation capabilities (Gourova and Toteva, 2011; Ahrweiler and Keane, 2013).
3) The resource perspective, wherein the input side of innovation is measured by R&D expenditure intensity, with a significant and positive impact on innovation (Gallié and Legros, 2012), or the firm size (Acs and Audrestch, 1991), which gives rise to different results.

This study aims to answer the following research question: How do different and multiple configurations of creativity, supporting organizations, and resources lead to TI and NTI in a scientific and technological park (STP)?

Considering possible complex combinations of the different conditions: creativity, innovation networks, and resources (Fiss, 2011; Ragin, 2008), we use a particular type of qualitative comparative analysis (QCA) methodology: the fuzzy-set QCA (fsQCA), a configurational method based on set theory that explains complex causality in terms of necessary and sufficient conditions to achieve the analytical outcome (Misangyi and Acharya, 2014).

The empirical study was conducted in ESPAITEC, a science, technology, and business park promoted by Universitat Jaume I (Spain), with a sample of 40 firms.

This study provides insights into new ways of conceptualizing firms' improvements in innovation by implementing a "right-factors configuration," a map of combinations of innovation ingredients. Fourteen theoretical combinations of TI and NTI were detected. We obtained empirical evidence for eight viable patterns.

The results showed that the only ingredient needed for TI or NTI is the combination of creative climate and creative intensity. This proves there is no unique way to obtain innovation (be it TI or NTI), but several ways are possible based on the mix of ingredients in the recipe.

The remainder of this paper is organized as follows. First, the main concepts are defined and a configurational framework is developed. Next, we explain the method used. Finally, we discuss the results, conclusions, and possible avenues for future research.

2. Literature review

2.1. The relationship between creativity and innovation

The concept of innovation has evolved over time, from Schumpeter (1934), during whose time innovation implied something new produced within the company that was marketable, to Godin (2004), who does not limit a product to something produced within the company but something that can be adopted from outside as well. The OECD (2005b), in its Oslo Manual, further expanded the term to include significant product improvements as innovations.

Innovation models have also advanced over time, from linear models such as Saren's (1984) or Rothwell's (1994) to interactive models such as Kline's (1985).

Likewise, Chesbrough (2003) proposes that, with an open innovation system, companies do not innovate alone but rely on other companies and institutions to drive innovation. Influenced by Von Hippel's (1988) work on informal and technical cooperation among companies, Lundvall (1992) coined the term National Innovation System based on List's National Production Systems (1841).

In the current environment, the pressure to innovate intensifies the need to consciously and constantly foster creativity within organizations (Gisbert-López et al., 2014). In the literature, creativity is viewed as a source of competitive advantage, a strategic tool, and an embedded philosophy that contributes to the motivation of employers and employees and improves performance and problem-solving (Fillis and Rentschler, 2010).

A key source of external and internal innovation for all firms is their employees' creativity (Cummings and Oldham, 1997). Their priority should be to hire people with the potential for creativity and then structure their employees' environment to achieve this creative potential. Previous research has investigated the factors related to the characteristics of a creative workforce and climate that can affect innovation (Chen and Huang, 2010). Therefore, we selected creative climate (the right place) and creative intensity (the right people) to study creativity in organizations and its influence on innovation.

According to Amabile (1988), Ekvall (1996), and Woodman et al. (1993), a creative climate is the environment within an organization that fosters or hinders the generation and practical application of ideas. It can be used as an accurate indicator of an organization's capacity to generate creativity (Çokpekin and Knudsen, 2012).

The relationship between creative climate and innovation is complex. Some authors have directly and positively linked the two concepts (Amabile et al., 1996; Barrett et al., 2005), whereas others have proposed factors that could favor the relationship (Gong et al., 2013). Some researchers have shown that this relationship could have an inverted U-shape (Del-Corte-Lora et al., 2015). Moreover, relationships between TI or NTI and creative climate have not been investigated in depth. Most existing studies are closely linked to technology-based innovation (Gisbert-López et al., 2014), and there has been a call for research on NTI (Černe et al., 2016). Klein et al. (2001) claimed a positive correlation between creative climate and process innovation (TI), while Zekic et al. (2018) found a positive relationship between creative climate and organizational innovation (NTI).

Creative intensity is defined as the proportion of workers in any industry engaged in a creative occupation (Bakhshi et al., 2013). Chen and Huang (2010) term the relative size of the creative personnel in a firm the creative workforce density and measure it as the ratio between the number of patent inventors and the total number of employees.

Few scholars have explored the size effect of the creative workforce on innovation performance (Chen and Huang, 2010). They have found that the number of creative people has both positive and negative side effects on innovation. Consequently, the relationship may be nonlinear. First, a high-density creative workforce can provide a rich source of original ideas, talents, and positive, innovative experiences (Walsh, 1995). However, the higher the density of the creative workforce, the more costly it will be to achieve effective communication and coordination among creative individuals. Thus, it will negatively affect the innovation outcome (Williams and O'Reilly III, 1998).

Regarding TI and NTI, creative individuals seem to have a greater impact on product innovations and modifications of existing products than on process innovations (Lee and Drever, 2013); however, their impact on NTI has not been studied.

Creativity is the key ingredient of innovation (Çokpekin and Knudsen, 2012); hence, a creative climate and/or creative intensity are either necessary or sufficient to attain innovation.

2.2. The relationship between innovation networks and innovation

Researchers are paying more attention to the importance of a firm's external networks to achieve higher levels of innovation (Corsaro et al., 2012; Laursen and Salter, 2006; Porter and Stern, 2001; Roy et al., 2004).

Among the different possible actors, the close interrelations between institutions and companies are considered to be the main drivers of innovation processes (Molina-Morales et al., 2014; Molina-Morales and Martínez-Fernández, 2010; Parjanen, 2012). Supporting organizations such as universities or technology centers allow firms to acquire innovation capabilities (Ahrweiler and Keane, 2013; Gourova and Toteva, 2011).

For this study, we defined supporting organizations as locally-oriented organizations that furnish firms with individual and collective support services. Examples of supporting organizations include research institutes, universities, technical assistance centers, vocational training centers, and trade and professional associations.

Previous research corroborates the positive effect of supporting organizations on firms (Lee et al., 2010). Knowledge and specialized expertise are essential to firms. They share knowledge, present multiple points of view, and seek to change others' ideas. The intermediating role played by supporting organizations enables them to search for external sources of information at a lower cost (Martínez-Fernández and Molina-Morales, 2004).

Two of the most significant supporting organizations are universities and technology centers. Universities have a pioneering influence on the industry through the existence of departments and research groups, which are, in turn, connected to technology centers. According to Janeiro et al. (2013), universities constitute a knowledge-intensive service industry, performing not only academic teaching functions but also extensive research and innovation-related activities (Abdul Razak et al., 2014). Universities have taken on new missions and objectives beyond their traditional tasks of teaching and research (Broström et al., 2021). In this context, expectations contribute to TI and regional development and offer solutions to societal problems (Geuna and Muscio, 2009). Etzkowitz and Leydesdorff (2000) indicated that the universities' "third mission" is to actively commercialize research output (NTI) and engage with societal actors through a wide range of formal and informal mechanisms at the individual and organizational levels (Perkmann et al., 2013; 2021). Technology centers consider research as the main means of sectorial development, offering companies the tools to resolve their technological development concerns and boost innovation.

Thus, by providing access to information and resources, supporting organizations foster managerial innovation and enable firms to gain new innovation capabilities and extend existing ones (Gourova and Toteva, 2011).

2.3. The relationship between resources and innovation

From the R&D perspective, R&D expenditure intensity has a significant and positive impact on innovation (Abdu and Jibir, 2018; Bilbao-Osorio and Rodríguez-Pose, 2004); Orlando et al. (2020) showed that the influence on the eco-innovation index is related to R&D expenditure. Other studies, such as that of Min et al. (2020), analyzed the effect of innovation network size and public R&D investment on regional innovation efficiency. Given the importance of R&D processes, Berchicci (2013) proposed an open R&D system to find a balance between internal and external R&D activities to capture the benefit from external technology sources. R&D investment enables the development of new products/processes (TI) and absorptive capacity to effectively assimilate knowledge from the outside (Cohen and Klepper, 1996; Cohen and Levinthal, 2000). R&D has been used as an antecedent to NTI. Černe et al. (2016) and García Álvarez-Coque et al. (2017) realized that R&D expenditure is affected in different ways based on the nature of the innovation (TI versus NTI).

Another organizational characteristic that can affect innovation is firm size (Acs and Audrestch, 1991). An extensive body of literature examines the relationship between firm size and innovation. However, these studies lack consensus regarding this relationship. A larger firm will have the ability to employ more R&D staff (Stock et al., 2002) that will, in turn, allow a firm to accumulate a larger store of technological knowledge and human capital skills (Damanpour, 1992) and access to financing and private appropriation of rents (Cockburn and Henderson, 2001). However, large firms have more complex operations, which can limit the amount of managerial attention available to evaluate employees' innovation (Ocasio, 1997). In general, a smaller firm may be more innovative because it is expected to be more flexible and better able to accept and effect change (Damanpour, 1992).

2.4. Configurational framework

Innovation may arise from the creativity generated within the firm (Amabile, 1988; Gisbert-López et al., 2014), the relationship it has with supporting organizations, such as universities or technology centers (Laursen and Salter, 2006; Lee et al., 2010; Molina-Morales and Martínez-Cháfer, 2016), or the resources it possesses and invests (Abdu and Jibir, 2018; Stock et al., 2002). Some authors, such as Amabile et al. (1996) and Çokpekin and Knudsen (2012), argue that innovation comes from the creative climate within the firm. However, others (Del-Corte-Lora et al., 2015) posit that the creative climate may only be positive for innovation to a certain extent; beyond this point, it may even have a negative effect. The same inverted-U effect could also be applied to the firms' relationship with supporting organizations and its effect on innovation (Laursen and Salter, 2006). Nevertheless, most scholars agree that these intermediary organizations bring specific knowledge to firms and thus generate innovation (Parjanen, 2012). Finally, resources can also hinder the creation of innovation (Lindholm, 1997).

When studying the complexity of innovation antecedents, some causal conditions that may lead to innovation have been identified, such as creativity, innovation networks, and firms' resources. As previously stated, these conditions have been studied separately, and the combination of different conditions can be complex (Fiss, 2011; Misangyi and Acharya, 2014). To address this gap, following Su et al. (2020), this study adopts a holistic perspective by developing a configurational framework that allows multi-contextual theoretical explanations.

Rather than considering that innovation (both technological and non-technological) depends on only one condition, this study considers it to be the result of the interaction of different dimensions of creativity (creative climate and creative intensity), relationships (with technological centers and universities), and resources (R&D investment and size), as seen in the configurational framework in Fig. 1.

As this study uses an inductive approach following Haxhi and Aguilera (2017), it does not state a priori propositions but develops new insights from the findings.

3. Method

Social sciences involve complex interactions that may have different ways of achieving the same outcome, and little importance is accorded to analyzing such relations.

In recent years, QCA has attracted academic attention (Järvinen et al., 2009; Roig-Tierno et al., 2017) because it combines the advantages of qualitative and quantitative techniques to examine complex causality. It was initially developed by Charles Ragin (1987), and its popularity has increased since the last version of the tool, fuzzy-set QCA (Ragin, 2008). In addition to being commonly applied to case studies, QCA is often used to analyze empirical data to allow analytical generalizations (Garcia-Alvarez-Coque et al., 2019).

Researchers have argued that QCA, in its different variants, provides superior applicability compared to traditional approaches based on correlation or the effects of independent variables on the outcome (Woodside, 2016). In this study, we used the fsQCA approach. Gligor and Bozkurt (2020) argued that fsQCA has sufficient exploratory power to be used as the main method.

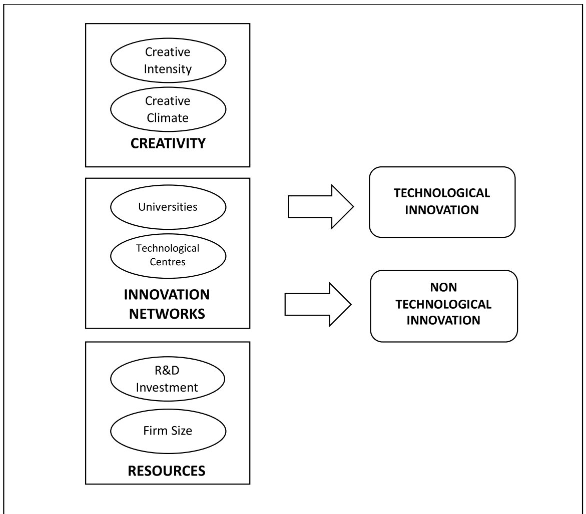
FsQCA is employed to analyze cases to identify relationships among present or absent conditions in the cases and the outcome of interest (Ragin, 2008). In other words, this method aims to identify the conditions that are necessary or sufficient for an outcome to occur (Gligor and Bozkurt, 2020). The results were examined for consistency and coverage. A high membership consistency is paramount because it implies that a condition will not exist in the presence or absence of the outcome. Coverage indicates the percentage of cases explained by a configuration (causal combination of ingredients).

The steps to investigate QCA are as follows: (i) identification of the conditions and outcome; (ii) analysis of the sample; (iii) calibration of conditions; (iv) necessity analysis; (v) "truth table" analysis; and (iv) sufficiency analysis.

3.1. Sample, data collection, questionnaire, and calibration

3.1.1. Sample

The empirical study was conducted using a sample of firms from ESPAITEC, a science, technology, and business park promoted by the Universitat Jaume I in the Valencian Community, Spain. The technology park model is a business agglomeration model that is present throughout Europe. The choice of the object of study, an STP, is based on the crucial role that parks play in today's knowledge economy. These parks create environments that foster collaboration, innovation, and entrepreneurship (Laspia et al., 2021) and help companies generate synergies to improve their competitiveness. These



*Model 1: **TI** = f (Creative Intensity, Creative Climate, Universities, Technological Centres, R&D Investment, Firm Size)*

*Model 2: **NTI** = f (Creative Intensity, Creative Climate, Universities, Technological Centres, R&D Investment, Firm Size)*

Fig. 1. Technological and non-technological innovation components.

activities started in 2007 with the aim of conducting, supporting, fostering, and assisting new innovative entrepreneurial initiatives. ESPAITEC focuses on new innovation firms such as information and communication technologies (ICT) and video games, nanotechnology and intelligent materials (technologies for industrial production; TIP), clean energies and water (sustainability, SOS), health and wellness (Health), and several other companies related to business management or education (others). This park is particularly interesting because the firms belonging to it have easy access to universities and science and technology parks.

To gather information, we collected primary data from firms belonging to ESPAITEC in 2014. We used a questionnaire (see Appendix 1) to obtain data from a sample of 40 out of the 57 firms that made up the park's population at the time.

Most companies in the sample (42.5%) were related to ICT and video games. In comparison, technologies for industrial production accounted for 20% of the sample, and health and wellness represented 12.5%. The remaining 25% were associated with sustainability (7.5%) and others (17.5%). Of the respondents, 65% were R&D Managers, whereas the remaining 35% were managers or partners of the firm. Finally, regarding the number of employees, 12.5% of the firms had at most two employees, almost half (47.5%) had between 3 and 10 employees, 30% had between 11 and 50 employees, and 10% were firms with more than 50 employees.

3.1.2. Data collection

Following Podsakoff et al. (2003), we ran tests to control for method biases. We emphasized procedural remedies to avoid common method biases resulting from the fact that the predictors (creative intensity, creative climate, relationships with technology centers and universities, R&D investment, and firm size) and criterion variables (TI and NTI) had been obtained from the same respondent. The measurement items, the context of the questionnaire items, and the context in which measures were considered were based on two actions. First, we performed the interview after the questionnaires were completed, using two media sources: e-mail and telephone, to reduce transient mood states of the respondent and artifactual covariance, independent of the content of the construct. Second, we asked a panel of academics and practitioners (13 managers and engineers responsible for firms' R&D activities or the production processes of ESPAITEC firms) to assess how well each item statement captured the corresponding concept. The panel made suggestions to modify items and change their order, scales, and anchors to improve the rhythm and reduce priming effects, context-induced mood, ambiguity, and social desirability in the answers.

3.1.3. Questionnaire

Content validity was assessed by defining the domains of the outcomes and conditions based on the literature (see Section 2). These variables are listed in Table 1 and Appendix 1. The domain of innovation (outcome) was based on the well-known scales frequently used in innovation research by the Ministry of Economy and the National Statistics Institute of Spain and the OECD (2005b), distinguishing between TI (product and process) and NTI (organizational and marketing innovations). Regarding conditions, we relied on Moultrie and Young (2009) to measure creative climate, Molina-Morales and Martínez-Cháfer (2016) for the intensity of relationships with universities and technology centers, Cohen and Levinthal (2000) for R&D investment, and OECD (2005a) to measure firm size.

Finally, we followed Chen and Huang (2010), who measured creative intensity as the ratio between the number of patent inventors and the total number of employees. However, as most of our sample (42.5%) belonged to the ICT and video games category, and software cannot be patented in Spain, we operationalized it as the number of creative staff in an organization. We measured it as the ratio of the number of employees generating ideas to the total number of employees.

3.1.4. Calibration

Before using fsQCA, the first step is to transform raw data into datasets. This step is known as calibration (Ragin, 2008) and indicates whether a value belongs to a set. Specifically, this study employed direct calibration, which defines three thresholds: completely in set (1), the point of maximum ambiguity (neither in nor out: 0.5), and entirely outside the set (0). Table 1 shows the main descriptive statistics of the outcome variables and conditions, the external criteria used for calibration, and the cutoff points. For a detailed description of the calibration procedure, see Ragin (2008, pp. 86–94).

4. Results

This study analyzed the causal configurations that allow for TI (product or process) and NTI (organization and marketing). It also checked whether any conditions were necessary and/or sufficient to obtain an outcome.

In particular, two models were analyzed (see Fig. 1). The fsQCA explained complex causality in terms of necessity and sufficiency. A condition is deemed necessary if the outcome cannot occur without this condition, whereas it is sufficient if the outcome occurs every time it is present (Legewie, 2013). Necessity and sufficiency analyses were carried out using the software fsQCA 3.0 (Ragin and Sean, 2016).

We first present the necessity analysis, followed by the sufficiency analysis. Finally, we answer the study's aim as stated in the introduction: How do different and multiple configurations of creativity, supporting organizations, and resources lead to innovation?

Table 1
Measures, descriptive statistics, and calibration points.

OUTCOME/CONDITION AND SOURCE	MEASURE INSTRUMENT	Descriptive statistics Max	Min	Mean (S.D)	Calibration Anchors* Fully in	Crossover point	Fully out	JUSTIFICATION AND REFERENCES
Tech. Innovation (OECD ,2005b)	The outcome has been built as the addition of the 5 items (2 for product and 3 for process). The maximum possible of 5 points and the minimum is 0.	5	1	3.85 (1.39)	5	4	0	The cut-off points have been established taking into account the maximum, the minimum and the average values. Woodside, A. G., Prentice, C., & Larsen, A. (2015)
Non-Tech. Innovation (OECD ,2005b)	The outcome has been built as the addition of the 8 questions (4 for organizational and 4 for marketing). The maximum possible of 8 points and the minimum is 0.	8	0	5.73 (2.89)	8	6	0	The cut-off points have been established taking into account the maximum, minimum and average values. Woodside, A. G., Prentice, C., & Larsen, A. (2015)
Creative Intensity (adapted from Chen and Huang, 2010)	The ratio of employees that suggest new ideas goes 1 to 4. The maximum possible of 4 points and the minimum is 1. *From 0 to 25% = 1* *From 26% to 50% = 2* *From 51% to 75% = 3* *From 76% to 100% = 4*	4	1	2.42 (1.08)	3	2	1	It is considered that there is a high creative intensity, if more than half of the staff suggests ideas to address. Feurer, S., Baumbach, E., & Woodside, A. G. (2016).
Creative Climate Moultrie and Young (2009),	The Condition has been built as the addition of 19 items about Organizational Motivation, Resources, Management practices and Overall assessment. The scale is 0–10 points (0 meant "strongly disagree" while 10 meant "totally agree". The theoretical maximum is 190 and the theoretical minimum is 19 points	175	83	131.25 (22.96)	150	120	90	Alpha de Cronbach = 0.87 The corresponding values have been assigned with the 75, 35 and 5 percentiles, respectively. In this way, the condition reflects a high creative climate. Misangyi, V. F., & Acharya, A. G. (2014).
Rel. Universities (Molina-Morales and Martínez-Cháfer 2016)	Level of frequency of the relationship with the Universities: *No relationship = 0* *Low = 1* *Medium = 2* *High = 3*	3	0	1.13 (0.88)	2	1.5	0	A medium level (2) of collaboration with the Universities is considered fully in the set. In this way, the condition reflects an active use of the Universities. Ragin (2008)
Rel. Tech. Centers (Molina-Morales and Martínez-Cháfer 2016)	Level of frequency of the relationship with the Technological Centers: *No relationship = 0* *Low = 1* *Medium = 2* *High = 3*	3	0	1.33 (0.94)	2	1.5	0	A medium level (2) of collaboration with the Universities is considered fully in the set. In this way, the condition reflects an active use of the Technological Centers Ragin (2008)
R&D Investment(Cohen and Levinthal, 2000)	Approximate percentage of turnover destined to R&D activities. The theoretical maximum is 100 and the theoretical minimum is 0 points.	90	0	22.25 (24.25)	50	15	0	The company is considered to make an important effort in R&D when it allocates 50% of its revenues. The 15% of those correspond to the median of the sample. Misangyi V.F. and Acharya A.G. (2014).
Size OECD (2005a)	Groups 1, 2 and 3 represent micro-enterprises while the rest of the groups (4, 5 and 6) would be small and medium enterprises. Number of employees: Up to 2 = 1 3-5 = 2 6-10 = 3 11-20 = 4 21-50 = 5 More than 50 = 6	6	1	2.77 (1,56)	6	3	1	It has been considered fully in the set when the company is medium. The crossover point has been established around micro-business (6–10 employees) Ragin (2008)

Note: As in Crilly et al. (2012), values of 1.99, 2.99, 3.99, 5.99 and 14.99 have been computed as 2, 3, 4, 6 and 15 in the fsQCA software. Furthermore, the values of creative climate have been truncated.

4.1. Necessity analysis

Table 2 shows the results of the necessity analysis. A condition is necessary if the consistency is higher than 0.9 (Schneider et al., 2010).

Table 2
Necessity analysis for technological and non-technological innovation.

	Tech. Innovation			Non-Tech. Innovation		
	Consistency	Coverage	RoN	Consistency	Coverage	RoN
Creative Intensity	0.823	0.631	0.462	0.764	0.579	0.429
~ Creative Intensity	0.307	0.743	0.925	0.338	0.809	0.943
Creative Climate	0.814	0.656	0.527	0.785	0.625	0.506
~ Creative Climate	0.375	0.789	0.925	0.380	0.792	0.926
Rel. Universities	0.533	0.796	0.885	0.508	0.751	0.863
~ Rel. Universities	0.634	0.605	0.618	0.472	0.535	0.675
Rel. Tech. Centers	0.678	0.803	0.840	0.663	0.777	0.823
~ Rel. Tech. Centers	0.484	0.554	0.684	0.472	0.535	0.675
Investment Innov	0.623	0.727	0.786	0.633	0.732	0.789
~ Investment Innov	0.571	0.664	0.747	0.515	0.593	0.710
Size	0.484	0.747	0.867	0.454	0.693	0.843
~ Size	0.676	0.633	0.623	0.676	0.626	0.619
Creative Intensity + Creative Climate	0.936	0.614	0.248	0.905	0.588	0.236

Note: (−) indicates the absence of this condition; (+) is the logical operator, OR.

In particular, no necessary condition allowed organizations to introduce TI and NTI. However, we observed that having high creative intensity and/or a good creative climate was necessary (consistency higher than 0.9) for the introduction of TI and NTI.

4.2. *Sufficiency analysis*

Prior to the sufficiency analysis, a truth table containing all possible logical combinations (Ragin, 2008) was generated. Following this, the minimum consistency value was set to determine the configurations that would be part of the result. According to Ragin (2008), the cutoff point must be over 0.75. The Quine−McCluskey minimization algorithm was then used to obtain the results.

The solutions listed in Table 3 correspond to parsimonious and intermediate solutions. The results were presented according to the system used by Fiss (2011). The large circles indicate core conditions, whereas a small circle indicates peripheral conditions, with "*the core elements being essential and the peripheral elements being less important and perhaps even expendable or exchangeable*" (Fiss, 2011, p. 294). This implies that the core conditions are the relevant ingredients (condition) of the recipe (causal configuration), and the peripheral conditions are the complementary ingredients. Furthermore, black circles indicate that the condition is present, whereas white circles indicate that the condition is absent. For the model to be valid, consistency must be higher than 0.75 (Fiss, 2011; Ragin, 2008). Specifically, the inclusion values of our models were 0.91 and 0.92, respectively, which were above the theoretical threshold of 0.75.

Model 1 (see Table 3) shows four causal configurations or patterns to achieve TI (products and/or processes). Pattern 1 shows that firms having a relationship with technology centers show a high intensity and creative climate, thereby generating TI (despite not making large R&D investments).

Patterns 2 and 3 show that high creative intensity and relationships with universities are key conditions to achieve TI. Specifically, Pattern 2 has two peripheral conditions (creative climate and relationship with technology centers). Pattern 3 also includes the following components of resources: R&D investment and size.

Pattern 4 (Model 1) shows that firms with more than six employees connected to a technological center (not universities), with high R&D investment and an excellent creative climate, contribute to TI.

Finally, for Model 1, as indicated by Ragin (2008), Pattern 1 had higher empirical relevance, as its coverage was higher (unique and raw coverage).

Model 2 (NTI) also had four causal configurations, which differed from those in Model 1 (see Table 3). Patterns 6 and 7 focused on "large" firms and the R&D investment effort and highlight the absence of relationships with universities. Creative intensity was present in all configurations, and creative climate was present in three of the four configurations.

Similar to Model 1−Pattern 1, Pattern 5 shows that relationships with technology centers and the contribution of creative intensity and climate lead to NTI.

Focusing on the causal configuration with high raw coverage and unique coverage (higher empirical relevance), Configuration 8 (Model 2) shows that firms with creative intensity and climate, relationships with universities and technological centers, and high R&D investment achieve NTI.

In sum, the following results can be highlighted:

(i) There are many ways to introduce TI and NTI in an organization. Both models presented four causal configurations or patterns to achieve innovation.
(ii) None of the conditions were sufficient or necessary. These conditions must be combined to achieve innovation.
(iii) Creative intensity and/or creative climate must be present (core or peripheral) in all cases.

Table 3
Sufficiency analysis.

	Tech. Innovation (*Model 1)*				Non-Tech. Innovation (*Model 2)*			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Creative Intensity	•	●	●		•	•	•	●
Creative Climate	•	•		•	•	•		●
Rel. Universities		●	●	○	○	○	○	●
Rel. Tech. Centers	●	•		●	●		•	•
R&D Investment	○		●	•	○	●	●	●
Size			•	●		●	●	
Consistency (incl.)	0.9201	0.9410	0.9527	0.9756	0.9107	0.9123	0.9524	0.9328
Raw Coverage (cov.r)	0.3667	0.3753	0.2785	0.2005	0.2645	0.2220	0.1978	0.3121
Unique Coverage (cov.u)	0.0825	0.0304	0.0233	0.0257	0.1011	0.0410	0.0168	0.1207
Solution coverage:	0.519284				0.497939			
Solution consistency:	0.911173				0.916089			

Note: As in Fiss (2011) • means presence of the condition. ○ means absence of the condition. Large circles mean core condition and small circles mean peripheral condition.
Consistency cutoff: 0.90. Frequency cutoff: 1.00. Calculated as per Medzihorsky et al. (2016). The absence of the outcome was performed but is not included. The solutions present no ambiguity and the expected directions both for Model 1 and Model 2 correspond to the vector (1,1,1,1,1,1).

As shown in Table 3, creativity appeared to be a key factor. Creative intensity and/or creative climate were necessary conditions. Creative intensity appeared in all patterns (except for Model 1—Pattern 4) as a core or peripheral condition to introduce TI and NTI. This was accompanied by creative climate in six of the eight patterns.

Concerning support organizations, companies seemed to choose between universities or technology centers, as they only had a relationship with both in two of the eight paths (Patterns 2 and 8). Thus, to introduce NTI, they preferred relationships with other technology centers, whereas for TI, they chose between universities and technology centers.

High R&D investment was not a necessary but a sufficient condition to introduce TI when combined with creative intensity and relationships with universities (Model 1—Pattern 3) and NTI when combined with creative intensity and without any relationships with universities (Model 2—Patterns 6 and 7). Finally, size always appeared with R&D investment (Model 1: Patterns 3 and 4; Model 2: Patterns 6 and 7).

Organizations that introduced TI did not present the same causal configurations as those that introduced NTI, according to the results discussed above. However, there were some similarities. Specifically, creative intensity or creative climate must exist in patterns that introduce TI and NTI.

5. Discussion

5.1. Theoretical implications

From an inclusive standpoint, this study illuminates new perspectives on how firms can improve their innovation by a "right-factors configuration." It bridges the gap in the literature, as few studies address the diverse determinants of a firm's innovation.

The main theoretical contribution of this study is its ability to measure the complex causality of innovation. This framework is an advancement in identifying the determinants of firm-level innovation by looking for a holistic viewpoint on the issue. Thus, in this study, we were able to measure this complex causality and analyze it in terms of sufficiency and necessity based on a small sample using the fsQCA methodology. Previous research has supported the importance of parks in favoring the development of innovation by companies (Bonacina Roldan et al., 2018; Figlioli and Porto, 2012; Kharabsheh, 2012; Moudi and Hajihosseini, 2011).

The analyzed companies can use three types of ingredients to generate innovation. First, creativity allows ideas to originate anywhere inside the organization and from internal interfaces through creative intensity and climate. Following Bellavista and Sanz (2009), creativity and innovation are the key components and driving forces in the development of STP and their impact: they jumpstart the economy of the surrounding area and their success feeds back to those organizations and institutions within the park that unleashed creativity initially. In turn, creative organizations and institutions in an STP inspire creative professionals and individuals at all levels, thus setting the conditions for growth. Second, innovation networks incorporate ideas from beyond the company's boundaries through their relationships with supporting organizations (Björk and Magnusson 2009; Ahrweiler and Keane, 2013). For example, several authors have argued that STPs facilitate relationships with universities and other research centers (Albahari et al., 2017; Díez-Vial and Montoro-Sánchez, 2016; Hobbs et al., 2017) and allow knowledge-sharing and the exploitation of spillovers or knowledge flows (Díez-Vial and Fernández-Olmos, 2015; Montoro-Sánchez et al., 2011). Being located in an STP positively affects product innovation by firms (Díez-Vial and Fernández-Olmos, 2015; Vásquez-Urriago et al., 2014) and increases the likelihood of cooperation for innovation (Díez-Vial and Fernández-Olmos, 2015; Vásquez-Urriago et al., 2016). Third, resources allow these ideas to be acquired and implemented for innovation. In our study, eight components that achieve innovation were determined, of which companies combine three main components differently to achieve innovation.

Our recipe analog identified the main and secondary ingredients (core and peripheral). The core ingredients can be combined, introducing three, two, or only one as the main element of the recipe. All combinations result in TI or NTI. In Fig. 2, we summarize the patterns encountered in our sample and the theoretical framework with the possible combinations proposed after our study.

Our first objective was to analyze the correct combination of ingredients that would allow us to generate both types of innovation. As shown in Fig. 2, only two combinations of core ingredients led to TI and NTI.

The use of innovation networks as the main ingredient is shown in Patterns 1 and 5. In both cases, the relationship with technological centers as a fundamental ingredient and creativity as a peripheral ingredient in its two components (intensity and creative climate) are key to promoting TI and NTI. In these two cases, there is an absence of R&D investment. Therefore, firms must have a wide range of sources of internal and external knowledge (Laursen and Salter, 2006) to be applied to a creative climate and/or creative intensity, which would act as a catalyst for that knowledge (Amabile et al., 1996; Çokpekin and Knudsen, 2012; Del-Corte-Lora et al., 2016).

In Patterns 3 and 8, companies have three ingredients at their core: creative intensity, the relationship with universities, and investment in R&D to achieve TI and NTI. The differences are that, for TI, size is added as a minor ingredient, but for NTI, a new main ingredient, the creative climate, and a minor ingredient, the relationship with technology centers, must be added. If companies choose this pattern, they must balance the three elements and enhance them as much as possible, which is why this is the most difficult combination.

Regarding the necessity and sufficiency analyses, the results show that the only ingredient needed was the combination of creative climate and creative intensity. However, they did not appear as the only main ingredient of the recipe and did not have any associated pattern in combination with the resources. Creativity, either with a creative climate or creative intensity, is similar to the relevance of salt in recipes. By itself, salt is not a dish, but it is crucial for the recipe to be a success. Thus, we can see creativity as a secondary or main ingredient combined with others in the eight patterns. It may not be the main ingredient in five of the eight patterns but is essential for the recipe of innovation. It is the only one of the three sets of ingredients that has no “absence” in any of the patterns. These findings contribute to the literature on creativity and

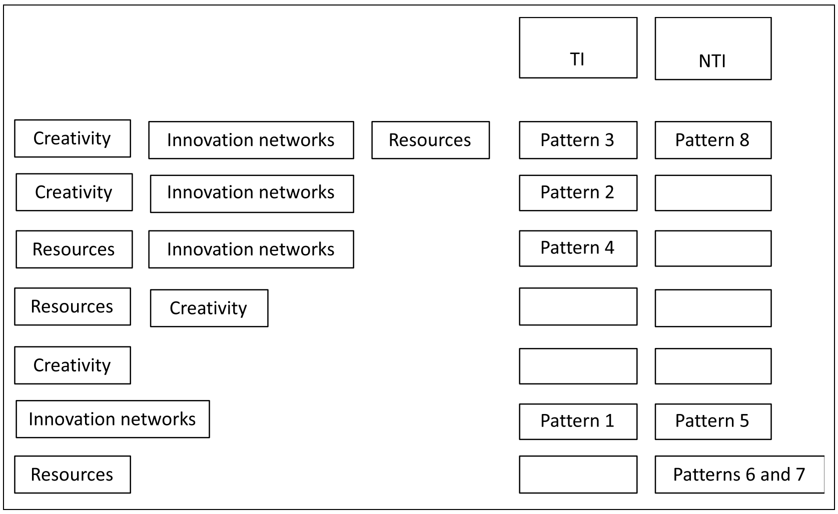


Fig. 2. Map of combinations of innovation ingredients.

innovation, as there are few contributions on the relationship between creativity in general or creative climate and creative intensity, particularly on the NTI (Černe et al., 2016).

No ingredients were sufficient on their own. Although the innovation network ingredient made it possible to achieve both types of innovation, it could not do so in isolation and needed peripheral ingredients such as creativity (intensity and climate) and the absence of R&D investment.

Finally, we compared the ingredients required for TI and NTI. Fig. 2 shows how the mechanisms of TI and NTI differ. Looking at the combination of the two ingredients, none of the three combinations (creativity and innovation networks, creativity and resources, and resources and innovation networks) led us to achieve the two types of innovation. In fact, in our sample, no combination of the two core variables allowed for NTI.

Two combinations led to TI: creativity and innovation networks (Pattern 2) and resources and innovation networks (Pattern 4). Thus, Pattern 2 combined creative intensity and relationships with universities as its main ingredients, whereas Pattern 4 combined size and relationships with technology centers as its core ingredient. Therefore, TI was nourished by innovation networks (contacts with universities or technology centers) and combined with creative intensity or size.

NTI was obtained by assigning more weight to resources. Thus, Patterns 6 and 7 used resources as a core element (investment in R&D and size) and creative intensity as a secondary ingredient; in both cases, a relationship with universities was absent. The difference between the two patterns was that one was committed to developing a creative climate, whereas the other was committed to having relationships with technology centers.

Finally, combinations of core ingredients were not found in our sample. Neither creativity alone nor the combination of creativity and resources led to both types of innovation. Resources, as the only core element, did not generate TI, and combining the two main elements (creativity and innovation networks, creativity and resources, and resources and innovation networks) did not lead to NTI. These results present avenues for new lines of research in the future.

5.2. *Implications for management and policymakers*

Our findings have several implications for business and policy. Companies that want to promote both types of innovation have two options. From a management perspective, Patterns 1 and 5 are the easiest to manage and most relevant in our sample. In both cases, strengthening relationships with technology centers, hiring creative staff, and designing a climate that favors creativity would be easy and affordable options for companies.

Specifically, the sample of companies used in this research belonged to a science and technology center and was characterized by high levels of innovation. The recipe that they followed, which can be used by companies who wish to innovate, is as follows: First, the relationship with other technology centers is the foremost component of the innovation recipe (Bonacina Roldan et al., 2018; Moudi and Hajihosseini, 2011; Vedovello et al., 2006). Openness to external sources allows firms to draw ideas from outsiders and deepen the pool of opportunities available to them (Albahari et al., 2017; Díez-Vial and Fernández-Olmos, 2015; Díez-Vial and Montoro-Sánchez, 2016; Vásquez-Urriago et al., 2014). Second, we identified creative climate and intensity as peripheral factors. Therefore, companies must reinforce recruitment processes by highlighting the creative capacity of applicants and designing a climate that favors such capacity development.

The second pattern is more complex, as Patterns 3 and 8 require mechanisms to coordinate the three ingredients (relationships with universities, investment in R&D, and creative intensity), which can reflect the positive and negative aspects of innovation.

If companies prefer to develop only one type of innovation, creativity will be a secondary element in both cases, with a stronger commitment to innovation networks and resources in the cases of TI and NTI, respectively. Thus, our study is consistent with previous research that describes the role of managers and employees as mechanisms to increase creativity (Bellavista and Sanz, 2009). Consequently, if creativity is necessary, managers could offer their employees tasks and jobs that support or facilitate social interactions inside and outside their organization to provide them with easy access to novel, non-redundant, or unusual information (Kim et al., 2018). Innovation networks are configured as key elements in product or process innovation. Thus, as a single element combined with creativity or resources, or as a simultaneous combination of the three ingredients, it will lead companies toward TI. This is possible because companies seek trends in products and processes, and technology centers and universities are good starting points for hard science. Furthermore, resources are key elements of market and organizational innovation. In this case, companies prefer to develop marketing mechanisms or organizational methods based on internal and external relationships with universities. The size, together with the specialization of the departments or the necessary investments in R&D, will allow the design or acquisition of the necessary elements to achieve NTI.

There is also a need for policies to encourage cooperation among different companies and between firms and research institutions, such as universities, as these are important for firms' innovative capacity (Camagni, 1992; Molina-Morales and Martínez-Fernández, 2011).

Technology centers are configured as incubators for companies, with few resources, that stand out for their high level of innovation. ESPAITEC, which is a hybrid center (science, technology, and business park) promoted by the Universitat Jaume I, has been recognized as one of the three most active technology parks in 2020, with the most actions and projects in the RED APTE (Association of Science and Technology Parks of Spain). This prize shows that the commitment to improving relationships between technology parks, universities, and companies is bearing fruit.

5.3. Limitations and scope for future research

This study presents certain limitations, some of which are related to the peculiarities of the analyzed case.

First, although this study was conducted on an STP (only ESPAITEC) and allowed us to increase our understanding compared to a more quantitative approach (Laspia et al., 2021), we understand that this could easily affect the number of relationships between the firms in the park and the university. Second, the main activities of most firms in the park were related to new technologies.

Regarding future research, we observe that theoretical innovation remains rich and ripe for further investigation. Therefore, isolating the different conditions and processes of creativity could provide better and more accurate results regarding how different configurations of creative climates affect innovation outputs. The same is true for different types of TI and NTI.

A second extension may include increasing the number of case studies and analyzing other science parks. This would enable us to analyze a greater number of cases and examine the degree to which the findings of this study are contingent on a specific context and can be extended to other competitive environments. Third, this study could be completed with the inclusion of KIBS as other important drivers for firm innovation performance. This would allow us to evaluate their role in the analyzed park and their relationships with the other drivers.

However, despite advances in our understanding of the evolution of innovation, what drives innovation remains elusive. Organizations invest heavily in systematic strategies to accelerate innovation; regardless, it is necessary to consider serendipity's role in innovation. In other words, improvisation can facilitate or provoke luck in innovation processes, which must be considered in the future.

6. Conclusions

In this study, we examined the interaction between three types of inputs (creativity, innovation networks, and resources) and their importance in obtaining the two types of innovation (namely, TI and NTI) in a sample of small companies belonging to an STP. We used QCA as an appropriate method to analyze the combination of “ingredients” in the “recipe” of innovation.

This study's contribution to the innovation literature is threefold. First, there are multiple combinations of inputs to obtain innovation as output. In our sample, we identified eight distinct patterns among the different possibilities of combining inputs to obtain TI and NTI (Figs. 1 and 2). Second, there are combinations of ingredients that generate both TI and NTI (Patterns 1, 5, 3, and 8), while other combinations lead to only one type of innovation (Patterns 2 and 4 for TI; Patterns 6 and 7 for NTI). Finally, although the inputs have different influences on TI and NTI, creativity (creative climate, creative intensity, or both) is the element that recurs in all patterns (either core or peripheral).

Declaration of competing interest

The authors declare no conflflict of interest.

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Appendix A

CREATIVITY

Creative intensity

Creative intensity: please, state the ratio of enployees that suggest new ideas.

	B.3
From 0 to 25%	1
From 26% to 50%	2
From 51% to 75%	3
From 76% to 100%	4

Creative climate. Please, state the level of agreement with the following statements (0 = Strongly disagree; 10 = Totally agree).

Organizational Motivation	
1	The organization shows the value of internal and external publications, etc.
2	The organization is orientated toward risk and opportunity
3	The organization is proud of its employees and their achievements
4	The organization is enthusiastic about the abilities of its members
5	The organization adopts an offensive strategy towards the future
6	Management systems and processes are flexible and adaptable
Resources	
7	There is adequate time to produce innovative ideas
8	All staff have the expertise to complete their job creatively
9	Unlimited funds are made available to all members of the organization
10	Material resources are available to all members of the organization
11	Members have free access to all the organization's information resources
12	A wide range of training opportunities are available to all employees
Management practices	
13	Project teams are given complete autonomy with their work
14	Individual skills and interests are a major factor in team selection
15	Project goals are clearly defined at the beginning of work assignment
16	Supervisors provide regular, clear feedback and support
17	Work groups are formed based on complementary personalities
Overall assessment	
18	In the firm there is a climate that fosters creativity
19	The firm can improve its creative and innovative performance through its creative climate

RELATIONSHIP WITH OTHER AGENTS

Relationship with universities and technological centers

Level of frequency of the relationship with the agent: *(1 = Low; 2 = Medium; 3 = High)*.

Agents	Frequency		
1.- Universities	1	2	3
2.- Technological centers	1	2	3

RESOURCES

R&D Investment

Aproximate percentage of turnover destined to R&D activities

Number of employees

	Up to 2	3–5	6–10	11–20	21–50	More
Employees	1	2	3	4	5	6

INNOVATION

During the last 3 years, has your firm introduced any of these innovations?

Product Innovations:
1.- New or significantly improved good or services that your competition already owned

(*continued on next page*)

(*continued*)

Product Innovations:
2.- New or significantly improved good or services that your competition did not own yet
Process Innovations:
3.- New or significantly improved production or services methods
4.- New or significantly improved logistic or delivery methods
5.- New or significantly improved process support activities
Organizational Innovations:
6.- New business practices in the organization
7.- New organizational methods in the workplace to improve the distribution of responsibilities and the decision making
8.- New organizational methods in external relations
9.- New organizational methods in external and internal knowledge management
Marketing Innovations:
10.- A new marketing method involving significant changes in product design or packaging
11.- A new marketing method involving significant changes in promotion
12.- A new marketing method involving significant changes in product placement
13.- A new marketing method involving significant changes in pricing

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