

Determining elements in organizational innovation: Factors and obstacles in Spanish companies

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Abstract

Organizational innovation (hereinafter OI) involves the use of new organizational mechanisms for the internal functioning of the company in areas such as the organization of the workplace or in the company's relationships with the outside world. Data has been taken from the Technological Innovation Panel (FECYT: Spanish Foundation for Science and Technology, 2012). The variables that affect the adoption of OI in companies have been analyzed, making an estimation of a trivariate probit statistical model, to which the method of maximum likelihood was applied. The results show a relationship of dependency between the different mechanisms of innovation in organizations and the need to control this interaction. The results highlight the existence of nine components or variables that have a positive relationship with the adoption of OI, among these the acquisition of external R&D and the need for training, thus corroborating the fact that for organizations that make efforts to increase their ability to acquire new knowledge, the introduction of OI serves as a complement.

Keywords: organizational innovations; capabilities; external and internal resources; obstacles.

JEL codes: O31.

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探讨组织创新之决定因素：在西班牙企业中的因素与障碍

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文章摘要

组织创新意指在企业内部的运行中使用新组织机制，范畴有如组织工作地点的结构，或组织企业的对外关系。本研究使用了技术创新小组（FECYT2012）的资料，对影响企业采用组织创新的变数进行了分析，利用最大似然估计法，估计出一个Probit Trivariate的统计模型。结果证明，在不同组织创新的机制之间是存有依赖关系的，同时也指出企业是有需要掌握这些有关互动。此外，研究结果也证实了有新构成部分或变数的存在，并对于采用组织创新有正面影响。当中包括研究开发（外部研究开发）的获得及有培训的需要，帮助奋力上进的各组织提高技能，让其获得新知识，而组织创新在这几方面可作为补充元素。

关键词: 组织创新、技能、外部及内部资源、障碍。

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1. Introduction

An OI is the implementation of new organizational methods in the business, in the organization of work and / or in relation to the outside environment (Organization for Economic Cooperation and Development, OECD, 2015). OI, as a strategy, is a key asset for companies (Liao and Wu, 2010), a source of value creation (Hwang *et al.*, 2008) and an instrument for publicising different organizational practices (Armbruster *et al.*, 2008). Companies participate in moves to innovate for several reasons. From increasing the performance of the company by reducing admin. costs or transaction costs; improving job satisfaction (and therefore productivity); and access to non-tradable goods, understood as those that are produced internally and cannot be acquired by the company's external environment; or the reduction of supply costs. Organizations also adopt OI in response to changes in managerial and technological knowledge, industrial competence, or future expectations of managers and shareholders as regards improving their level of performance (Damanpour *et al.*, 2009, Yamakawa and Ostos 2012, Varela and Méndez, 2017).

The identification of the determining factors that drive companies to introduce innovations is useful when examining the factors that drive innovation activity in companies. In addition, thanks to the identification of these factors, companies can increase their competitiveness and develop their business in new markets (OECD, 2015). In general, the inclusion of innovation is a factor that facilitates the company's adaptive behaviour through changes in the organization. Going ahead with innovative initiatives enables organizations that introduce early changes to be aware of the latest developments, absorb new knowledge and increase their opportunities to benefit from innovative moves (Cohen and Levinthal, 1990, Roberts and Amit, 2003).

Therefore, we consider the relevance, effects, and importance that adoption of and adaptation to OI has for companies. However, despite venturing all the benefits that OIs may have, it is necessary to continue delving more deeply into the difficulties presented by the analysis of the objectives of OI. On the one hand, the problems of conceptualization and, on the other, the difficulty of measuring these has made it hard to incorporate a consensus-based operational concept of OI. Both of these circumstances have led to much of the literature on these issues using different concepts to refer to these innovations, so the possibility of making comparisons and extending the conclusions obtained in some studies to a more general level, is by no means straightforward (Afcha, 2011).

From 2001 onwards, the European Statistics Office (EUROSTAT, 2005), in an attempt to standardize the measurement and quantitative analysis of OIs, included questions in relation to the incorporation of OIs and their consequences for organizations into the questionnaire of the European Innovation Survey. Currently, the definition of OI that is used by the CIS (Spanish Centre for Sociological Research) is based on the one proposed by the Oslo Manual (OECD, 2015). This makes it easier to run a quantified follow-up of three different categories of IO. The data used

throughout this article corresponds to PITEC (the Spanish Technological Innovation Panel) (FECYT – Spanish Foundation for Science and Technology, 2012).

The main contribution of this article, based on the information provided above, is to determine the factors that affect the integration of new organizational mechanisms in three fields, i) the internal way of working in organizations that includes business intelligence mechanisms, ii) the way of organizing the workplace and, iii) the links with the outside environment that had not been previously exploited by the organization. This is an issue that up to now has not been discussed a great deal in the literature, and on which, as authors gradually appear, will increase knowledge of the mechanisms that are related to incorporating or producing IO.

On the other hand, this contribution is also part of understanding the obstacles or barriers that companies face in the adaptation and production of IO, as a complement to the main objective, since, at the same time, these are decisive when it comes to taking the decision to innovate in the organizational part of the company.

2. Review of the literature

2.1. Organizational Innovation

It is considered that an OI includes any type of change that aims to optimize the integrated processes in the heart of the organization (OECD, 2015). These changes involve the introduction of an idea or behaviour that did not previously exist in the organization, and which the company incorporates in order to increase its profitability (Daft, 1978, Damanpour and Evan, 1984, Birkinshaw *et al.*, 2008).

Sometimes, differentiating between processes and organizational innovations is a real challenge, since both types of innovation proposals serve to reduce costs through new and more efficient processes of production, distribution and internal organization. It is common to find that many innovations will contain aspects of both types of innovation. A starting point for the process of differentiating oneself through OI is the type of business: process innovations deal mainly with the implementation of new equipment, software and specific techniques or procedures, while OIs refer mainly to people and the organization of work, often being termed structural OIs (Eurostat, 2005). These consist of the change in responsibilities, accountability, decision-making channels, and information flows, as well as the number of hierarchical levels of structure in the division of functions and responsibilities. In particular, an OI is the implementation of a new organizational method in the business practices of the company, the organization of the workplace or external relations (OECD, 2015), which has not been adopted before in the company. All this is the result of strategic decisions taken by management. The literature states that an OI is an important way forward for companies (Liao and Wu, 2010), a source of value creation (Hwang *et al.*, 2008) and an indicator for internal dissemination within the different organizational practices (Armbruster *et al.*, 2008).

2.2. The objectives of organizational innovation

An organization can carry out innovation activities for a variety of reasons, which must be identified according to their economic objectives (Guan *et al.*, 2009). These objectives may be related to products, markets, efficiency, quality, or the ability to learn and implement changes (Eurostat, 2005).

The perception of the company by society, in terms of innovation and organization, suggests that different types of companies may have different objectives in terms of primary innovation (Leiponen and Helfat, 2009, Yang and Hsiao, 2009), due to variations in innovation patterns and the environment in which they operate. Specifically, Guan *et al.* (2009) reveal significant differences concerning the importance of innovation objectives on the basis of their company type (high-tech versus non-technological companies), ownership (state enterprises versus non-state enterprises), resources for innovation (having an R&D department versus no R&D department), and size (small and medium companies compared to large companies). The literature also distinguishes between product innovation and process innovation. Leiponen and Helfat (2009), establish that it is likely that companies also have specific objectives for each type of innovation. Companies not only have to turn their attention to improving efficiency and productivity but also to developing innovation mechanisms aimed at stimulating the creation, exchange and integration of knowledge (Albers and Brewer, 2003). This means that action to innovate is conceived as an objective to improve the exchange of knowledge.

The maintenance, acquisition and evolution of a company's capabilities depend on its innovation objectives and the resulting innovation strategy (Burgelman *et al.*, 2005). Therefore, the objectives of innovation determine the action taken to innovate and its results.

In conclusion, we can say that companies seek in innovation a way to obtain competitive advantages over other companies in the sector, through an anticipated reaction (Geroski, 1995, Roberts and Amit, 2003). The great relevance of OIs in the business struggle has been confirmed in several research projects that aim to analyze the impact of OIs on the performance or profitability of companies (Damanpour and Evan, 1984; Caroli and Van Reenen, 2001; Greenan, 2003; Piva *et al.*, 2005). All this research reveals the existence of two different points of view. On the one hand, it indicates that the OIs work as a prerequisite for the assimilation of technical change and, therefore, have a favourable effect on technological innovations in processes and products. On the other hand, we find a series of authors, who point out that OIs are a great source of competitive advantages, since by themselves they have a relevant effect on profitability and productivity, as well as other aspects such as delivery times, quality and / or flexibility (Womack *et al.*, 1992; Hammer and Champy, 1993; Goldman *et al.*, 1996).

The effect of OIs on companies makes it easier to acquire and integrate new knowledge by using these innovations as a frame of reference to achieve technical innovation in the organization. Due to this, making changes within organizations

is considered a necessary requirement to be able to drive technological innovations (Lam, 2006). This effect has been proven through various different current empirical studies, where it is observed that, if both technological and organizational innovations are implemented, synergies are produced that have an impact on the productivity and performance of the organization (Damanpour *et al.*, 2009, Polder *et al.*, 2010, Yamakawa and Ostos 2012, Varela and Méndez, 2017).

2.3. Theory of resources and skills in the adoption of innovations

The first known reference, entrusted with analyzing the nature and significance, at strategic level, of a company's ability to differentiate itself in terms of new products and processes was Leonard-Barton (1992). Subsequently, different authors (Henderson and Cockburn, 1994, De Carolis and Deeds, 1999, De Carolis, 2003, Sher and Yang, 2005) have done studies, mainly in the field of high technologies, on the results of OIs for the performance of resources and capabilities. There are also authors (Kusunoki *et al.*, 1998, McEvily and Chakravarthy, 2002, Souitaris, 2002, Brusoni *et al.*, 2005, Chen *et al.*, 2006, Prajogo and Ahmed, 2006, Kleinschmidt *et al.*, 2007, Fierro *et al.* al., 2013) who have attempted to analyze the influence that factors such as resources and capacities have on the innovative performance of organizations.

2.3.1. *The resources and capabilities of organizations*

Focussing the analysis on the resources and skills available to organizations from the two fundamental principles which Barney (1991) bases himself on: 1) Companies differ greatly in the capability and resources they have, or over which they maintain some control, and 2) that difference maintains a stable trend over time because there are a number of resources that cannot be acquired in the market or that cannot be transferred from one company to another as easily as others.

Barney's theory (1991) finally divided into two different approaches, firstly, the approach based on the dynamic capabilities stressed by a number of authors (Teece *et al.*, 1997, Eisenhardt and Martin, 2000). As it has gradually become necessary to undertake a deeper analysis of the mechanism of creation or development of resources and skills, and the updating of both the resources and the capabilities that organizations have in line with the changes that occur in the environment, these aspects have been analyzed using the approach based on the resources and capabilities of the organizations. The second approach that arose from Barney's theory (1991) is based mainly on knowledge (Nonaka, 1994, Grant, 1996, Spender and Grant, 1996, Nonaka and Toyama, 2005), since the role of intangible resources has become foremost in generating and maintaining competitive advantages (Barney, 1991, Grant, 1996).

Intangible resources are mainly based on knowledge, which, as it is not quantifiable and measurable, classifying or quantifying it is an arduous task that in many

cases becomes impossible (Grant 1999). For Liebeskind (1996) knowledge is the most important asset that a company can have. In this research, all those resources based on knowledge, as we will see later in the results of the model, take on special relevance. The difficulty with regard to the handling of knowledge is due to the fact that several authors have pointed to knowledge as the main element of innovation processes (Miller *et al.*, 2007). However, for these resources to have the ability to generate a competitive advantage that is maintained over the long term, they must meet certain characteristics: they must be heterogeneous, imperfectly imitable, substitutable and mobile (Barney 1991, Peteraf 1993).

2.3.2. The obstacles or barriers to innovation

In the field of both technological and non-technological business, knowledge is one of the main sources of competitive advantage (Kusunoki *et al.*, 1998, McEvily and Chakravarthy, 2002). In many situations, technological innovation is due to the fact that there has been an increase in prior knowledge in the company. This knowledge has been developed and accumulated internally in the organization and transmitted to individuals and groups that have generated new processes or products (Leonard-Barton, 1992).

Companies face the challenge of acquiring new knowledge in different ways. The way to acquire knowledge is laid down by the strategic part of the company. This has certain effects on innovation processes, regardless of their type. If we focus on technological knowledge, this can be increased either by developing it internally in the organization or by acquiring it through relationships that the organization can maintain with other organisations abroad (Sher and Yang, 2005 and Fierro *et al.*, 2013). Therefore, we must distinguish between those resources that are based on knowledge generated internally by the company (endogenous knowledge) and what is based mainly on the acquisition and integration of knowledge from outside the company (exogenous knowledge). The choice of one or the other will depend on factors such as the size of the company or the sector. There is also extensive literature on knowledge management that focusses on differentiating between what is called tacit knowledge and explicit knowledge (Nonaka, 1994, Evans *et al.*, 2002, Holden and Glisby, 2010). Explicit knowledge is easier for the company to make use of, however since it is characterized by the fact that it is easily transferable and it is also easier for other companies to imitate. On the other hand, tacit knowledge is the opposite case, and this difficulty of transfer is what enables it to be more likely to be a sustainable competitive advantage. Therefore, resources can have a significant impact on companies' innovative character depending on the degree to which they are codified (McEvily and Chakravarthy, 2002, Edmondson *et al.*, 2003, Brusoni *et al.*, 2005). Edmondson *et al.* (2003) point out that there will be more heterogeneity between the performance of companies when it is based on tacit knowledge than when it is based on explicit knowledge. Therefore, it is considered basic to distinguish between resources based on tacit knowledge and resources based on explicit knowledge.

Tacit knowledge is fundamentally subjective, being deeply rooted in organizations; it is based on the experience, beliefs and perspectives of individuals (Schulz and Jobe, 2001). This knowledge is generated and transferred through the interrelationships between the different individuals that make up the organization. That is why a part of the knowledge needed to be able to innovate is found in organizations and is utilized by individuals (Subramaniam and Youndt, 2005).

Although, currently, tacit knowledge is considered key in order to have the capacity to achieve a competitive advantage in the long term, it cannot completely replace explicit (codified) knowledge. Balconi (2002) points out that tacit knowledge should be based on codified knowledge, as Brusoni *et al.* (2005) also indicate, declaring that the investments that organizations make in R&D and in R&D personnel help to access sources of codified knowledge.

In general, a large percentage of companies do not have the necessary resources to achieve a high level of productivity in their technological and non-technological innovation processes. That is why these organizations must be conscious that they must have not only endogenous knowledge when innovating a product, service or process, but also the ability to identify and integrate that exogenous knowledge that is crucial to undertake their innovation processes (De Propris 2000).

Nevertheless, it is difficult for an organization to assess, absorb and utilize exogenous knowledge if the organization does not have the necessary skills to generate this internally (Cohen and Levinthal 1990). Both authors point to a new concept, the capacity of absorption, which they designate the ability with to adequately assess new information, assimilate it and use it for sales purposes. Henderson and Cockburn (1994) base their arguments on the fact that the ability of the organization to achieve and integrate this knowledge of external origin is a remarkable competitive advantage. This ability can only be acquired through so-called learning by doing (Cohen and Levinthal, 1990). This knowledge acquired from outside is composed of a part of both tacit and explicit knowledge. With regard to the former, it is difficult to transfer between organizations if there is no close link between them.

2.4. The obstacles or barriers to innovation

There are a lot of studies that discuss how the barriers facing innovation depend on specific factors. One of the most important is size, (Piatier, 1984, Dougherty, 1992, Henderson, 1993): where small and newly created organizations face more obstacles (Hadjimanolis, 2003, MacCann, 2009). Another key factor is the stage at which the degree of innovation is found, the moment at which the decision to innovate occurs, or once it has begun its innovative process, by increasing its efforts (Mohnen and Röller 2005).

The location of organizations is another point to be aware of when innovating, since legislations, infrastructures, regulations, etc., are not the same in all places (Tourigny and Le, 2004). They also determine that the sector is another important

factor. In the study of these authors it can be seen how companies in low and medium intensity technology sectors face fewer barriers than those that are highly technological.

3. Organizational innovations: a statistical model

The data used are taken from PITEC 2012. This survey, run annually since 2001, replicates for Spain the questionnaire used by the CIS. In this way, the questions asked in PITEC coincide with the different editions of the CIS questionnaire.

The PITEC questionnaire defines OIs as the implementation of new organizational methods in three areas: i) the internal functioning of the company (including methods / systems of knowledge management); ii) the organization of the workplace; and iii) the external relationships that have not been previously used by the company. This implementation must be the result of strategic decisions made by the company's management. This excludes mergers and acquisitions, even if these would mean new features of organization for the company.

An OI must be the result of strategic decisions taken by the management of the company. The decision as to the type of OI embarked on does not appear to be an independent decision but rather, on the contrary, a decision that is made simultaneously. The application of univariate models to determine the probability of introducing organizational innovation of any of the three types mentioned above would not be adequate for an analysis of this type of situation, given that it could be correlated.

To solve this problem, we propose the estimation of a trivariate probit model, a regression model that enables three dichotomous dependent variables to be simultaneously estimated. This model explicitly considers the existence of autocorrelation in the error term and, therefore, controls the bias arising due to the existence of correlation between unobservable variables that determine the adoption of the different innovations.

The trivariate probit model that identifies the variables that influence the introduction of OI is determined by the variables described in table 1:

Table 1. Description of the OI variables (In-house)

Dependent variables	Description
Organizational Innovation 1 (OI_1)	New company practices in the organization of work or company procedures.
Organizational Innovation 1 (OI_2)	New methods of organizing workplaces in their company in order to achieve a better share-out of responsibilities and decision-making.
Organizational Innovation 1 (OI_3)	New methods of management of external relations with other companies or public organizations.

$$\begin{aligned}
 OI_1^* &= \beta_{11}x + \varepsilon_1 & OI = 1si & OI_1^* > 0, \\
 OI_2^* &= \beta_{21}x + \varepsilon_2 & OI = 1si & OI_2^* > 0, \\
 OI_3^* &= \beta_{31}x + \varepsilon_{31} & OI = 1si & OI_3^* > 0,
 \end{aligned}$$

Where OI_1^* , OI_2^* , and OI_3^* represent the true unobserved values of the tendency to introduce OI related to: i) the introduction of new business practices in the organization of the work or company procedures (includes methods / systems of knowledge management); ii) new methods of organizing workplaces in the company with the objective of a better distribution of responsibilities and decision-making; and iii) new methods of managing external relations with other companies or public institutions. OI_1 , OI_2 and OI_3 are the observed dichotomous variables that indicate whether the company introduced any of the above mentioned OI types. X is a vector of variables that influence the probability of introducing some type of innovation, and ε , the random error term.

From the estimate of this probit model it is possible to calculate predictions of the probability of introducing an OI type 1, 2 or 3, and incorporating it to determine the effect of the OIs. The result of this first estimate will, on the one hand, enable us to meet the first objective set to identify the determining factors of the three types of organizational innovation, and on the other, to solve the problem of sampling selection.

In the period between 2010 to 2012, the period selected for the study, we will take 100% of the companies that make up the PITEC sample (see table 2), that is, 9,612 companies that have taken measures of technological and non-technological innovation.

Table 2. Distribution of the number of innovative companies, according to the PITEC classification (2012) (In-house)

	No. of Companies	Companies %	Accumulated Percentage
1. MEG	1,584	19.3	19.3
2. MID	5,765	60.0	79.3
3. MFG+MID	961	10.0	89.3
4. MIDE	329	3.4	92.7
5. MEP	703	7.3	100.0
Total	9,612	100.0	

3.1. Measurement and description of the independent variables that influence the adoption of OI

As already indicated in the previous section, the PITEC information is used to obtain the proxies of each of the variables involved. We see in Table 3 a description of the independent variables that affect the adoption of OI and that have been used in our model to see the effect that OIs have on these companies.

Table 3. Independent variables that affect the adoption of OI (In-house, from PITEC data (2012))

Technological factors	Procurement of R+D (external R+D)
	Procurement of machinery, equipment and software
	Procurement of other external knowledge of innovation (not included in R+D)
	Innovation (not included in R+D)
	Introduction of innovations into market
	Designs and other preparations
	Application for patents
Use of protection: record of useful models	
Obstacles to innovation	Lack of company funds
	Lack of financing by external sources
	High costs of innovation
	Lack of qualified personnel
	Lack of information on technology
	Lack of information on markets
	Difficulty in finding partners
It is not necessary as there is no demand for innovations	
Human resources	No. of employees in t
	Training
	No. of workers in internal R+D
	No. of external consultants
Financing	Public financing: Local and regional administrations
	Public financing: State administration
	Public financing: European Union

In previous sections we have been identifying the variables that are most directly linked to the theory of resources and capabilities of the company, and more specifically the theories about the type of knowledge that the company needs to be able to innovate. In our model we have incorporated other variables that we have understood can meet the objective set out in this article: which factors, depending on the particular approach used, influence measures to innovate as regards incorporating OI in the company (see table 4).

Table 4. Description of the independent variables depending on the approach used (In-house)

Focus	Variables	Measure of variables
Resources based on tacit endogenous knowledge	No. of workers in internal R&D	Number of workers devoted to internal R&D work: proxy
Resources based on explicit endogenous knowledge	“Industrial property rights”	Request for patents (significant or radical innovations): dummy
		Use of protection: registering useful models (incremental innovations): dummy
Resources based on tacit exogenous knowledge	Acquisition of outside knowledge	Acquisition of other external knowledge (not included in R&D): dummy
		Expenditure on training for R&D
Resources based on explicit exogenous knowledge	Acquisition of outside knowledge	Acquisition of R&D (external R&D): dummy
	Investment in R&D	Acquisition of machinery, equipment and software: dummy

The independent variables used to estimate the regression that identifies the factors affecting adoption of the different types of OI are listed below. Table 4 shows these variables classified into four dimensions. First, it includes a set of variables that indicate the actions to innovate taken by the company to obtain new products, services or processes, based on the application of science and technology.

As already pointed out, OI promotes other innovation by the company, so that OI measures can also be conceived as a way to surmount some of the obstacles faced by companies to be able to innovate. That is why the variables that indicate whether the company has certain barriers to innovation have been included, following those asked about in the EIN¹.

(1) Cost factors: lack of internal and external funds and high cost; Knowledge factors: lack of qualified personnel, lack of information about technology, lack of information about markets and difficulty in finding partners; Market factors: dominance of established companies, uncertainty

The size of the company, measured by the number of employees, has been indicated in empirical studies as a determining factor in the adoption of IO. It is expected that larger companies have the necessary resources to undertake IO and that, on the other hand, the need to maintain an organizational structure appropriate to its scale produces additional pressure on larger companies. Likewise, the incorporation of IO requires fundamentally skilled workers to undertake changes internally. To measure the influence of this factor, the number of employees devoted to R&D, according to their qualifications, is taken into account.

Finally, three variables are included that are related to the financial capacity of the company to undertake IO. For this we use the percentage of public funds received in order to take action of an innovative nature.

4. Organizational innovations: results

The results of trivariate probit estimation are shown in table 5, “determinants of the introduction of IO”. As already anticipated in the description of the model, note the statistical significance of the correlation coefficients (see table 6) between the different types of OI. This result confirms the need to adopt a multivariate approach to obtain a correct prediction of the probability of introducing OI. Given the nature of the types of OI, where the existence of common elements in companies that adopt one or several of the different types of IO could be an explanation for this interdependence.

Following this approach, the results place the capacity for knowledge acquisition as an element that acts transversally in the adoption of different OIs (Chang and Lee, 2008). In this case study, the results obtained enable us to identify nine variables that positively affect the adoption of the three types of IO: these are the variables related to “Acquisition of R&D (external R&D)”, “Acquisition of machinery, equipment and software”, “Introduction of innovations in the market” and “Use of protection: registration of useful models”, with regard to technological factor. Regarding obstacles to innovation, we find that the factor of “No need for innovations due to lack of demand for them” has also had a positive relationship in the three types of IO. On the human resources side, we see that the “Number of employees in period t”, “Employee training activities” in the current period, and “Number of external consultants” also have a positive effect. Lastly, “Financing of public administration” also shows a positive relationship. These variables clearly affect the capacity of knowledge acquisition of the company, confirming to a certain degree that in companies that reinforce their ability to assimilate new knowledge, introducing OIs has a complementary effect, that is, the adoption of one type of OI positively influences the tendency to adopt another type of organizational innovation.

regarding demand; Other reasons not to innovate: lack of demand for innovation and no need for innovation in the markets.

The authors Damanpour *et al.* (2009) and Polder *et al.* (2010) demonstrate a similar relationship when analyzing the interaction between non-technological innovations and technological innovations, confirming that, in the presence of IO, the introduction of technological innovations has a greater effect on the performance of the company.

Next, we shall analyze the relationships obtained for each of the three types of OI examined (table 5). The first three columns show the results regarding the introduction of new business practices in the company's organization of work or the procedures: thus IO₁, everything related to knowledge management. This type of innovation is positively affected by factors related to technological aspects and the company's information flows. This is partially confirmed by the positive influence of the size of the company on the introduction of new knowledge systems, since, in general, larger companies handle larger information flows, thereby increasing the complexity of its management and correct assimilation. Another element that significantly influences the adoption of new knowledge management systems is the introduction of information and communication technologies (ICTs). The statistical significance of the variable, purchasing machinery, software and hardware confirms the importance of these technologies in the implementation of OI. The relevance of ICT in the implementation of OI has been evident in the work of Polder *et al.* (2010) and Gu and Gera (2004). The introduction of innovations in the market, as well as preparations for products and distribution also have a significant influence. Finally, as technological factors, we must consider the positive influence of patent applications and the use of protection: the registration of useful models.

Table 5. Determinants of the introduction of IO. Probit Trivariate model. In-house from PITEC data (2012)

	Org. Innov. 1			Org. Innov. 2			Org. Innov. 3		
	Coeff.	Error	Sig.	Coeff.	Error	Sig.	Coeff.	Error	Sig.
Technological factors									
Procurement of R&D (external R&D)	.173	.029	.000***	.167	.029	.000***	.180	.036	.000***
Procurement of machines, equipment and software	.237	.034	.000***	.156	.035	.000***	.095	.043	.027**
Introduction of innovations into the market	.181	.032	.000***	.186	.032	.000***	.233	.038	.000***
Procurement of external knowledge	-.062	.087	.480	-.001	.087	.995	-.025	.103	.805
Introduction of preparations for prod./distrib.	.109	.048	.024**	.071	.049	.147	.009	.059	.874
Applications for patents	.093	.038	.015***	.091	.039	.018**	.070	.046	.129
Use protection: registration of useful models	.164	.049	.001***	.160	.049	.001***	.141	.059	.017**

	Org. Innov. 1			Org. Innov. 2			Org. Innov. 3		
	Coeff.	Error	Sig.	Coeff.	Error	Sig.	Coeff.	Error	Sig.
Obstacles to Innovation									
Lack of funds within the company or group	.009	.016	.571	.012	.016	.460	.021	.021	.328
Lack of external financing for company	-.013	.016	.424	-.019	.016	.242	-.049	.021	.023**
High costs of innovation	-.006	.014	.651	-.002	.014	.903	.019	.018	.289
Lack of qualified personnel	-.032	.018	.076*	-.031	.018	.095*	.020	.024	.389
Lack of information on technology	-.028	.023	.228	.003	.024	.896	.036	.030	.235
Lack of information on the markets	-.012	.020	.541	-.026	.020	.196	-.073	.026	.005***
Difficult in finding partners for coop over innovation	.000	.014	.979	-.007	.014	.639	-.076	.018	.000***
Not needed/lack of demand for innovations	.126	.012	.000***	.124	.012	.000***	.111	.016	.000***
Human Resources									
Number of employees in t	.000	.000	.000***	.000	.000	.000***	.000	.000	.000***
Expenditure on training for R+D	.328	.035	.000***	.320	.035	.000***	.278	.042	.000***
No. of workers in internal R+D	.000	.000	.252	.000	.000	.191*	.001	.000	.002***
Number of external consultants	.128	.056	.022**	.236	.055	.000***	.162	.065	.013**
Financing									
Public funds: Local or regional	.079	.034	.020**	.024	.035	.494	.044	.042	.292
Public funds: State administration	.075	.033	.023**	.082	.033	.013**	.169	.039	.000***
Public funds: European Union	.096	.050	.054*	.041	.051	.419	.120	.058	.038**
Intersection	-1.457	.055	.000***	-1.482	.055	.000***	-1.865	.073	.000***

*** Significant to 99 percent confidence.

** Significant to 99 percent confidence.

* Significant to 90 percent confidence.

Regarding obstacles or barriers to innovation, we see that the variable that make reference to not implementing innovations due to it not being needed as a result of market demand has a very significant influence. The lack of the qualified personnel variable was found to be something significant.

The variables related to the qualification of human resources also exert a significant influence on the incorporation of this type of OI. Both the investment in training, and the recognition by the company of lack of qualified personnel to adequately

develop their innovations, show that companies that incorporate new knowledge management systems are interested in improving and overcoming the barriers arising due to the shortage of human capital revealed by the company. Likewise, the need to have expert external consultants who work in situ in the company is shown as positively significant.

Finally, we looked at the variables related to public financing of innovation activities, where there was a positive influence exerted by the three types of financing proposed, with financing from the European Union being the least significant.

Table 6. Correlations between the three types of IO. In-house

Correlations (Spearman's Rho)			
		Coeff.	Sig.
Org. Innov. 2	Org. Innov. 1	.708**	0.000
Org. Innov. 3	Org. Innov. 1	.473**	0.000
Org. Innov. 2	Org. Innov. 3	.488**	0.000

** The correlation is significant at level 0.01 (bilateral).

Columns 3, 4 and 5 pertain to the estimation of OIs that imply new methods of organization in the workplace, IO_1 . These innovations are associated with the improvement in the share-out of responsibilities, the decision-making process, or the management of their work teams. In this sense, the results show that the companies that invest in training their workers, in the procurement of equipment that can lead to greater productivity of these workers (investment in machinery, hardware and software) and in hiring external consultants, are more likely to adopt new methods for the organization of workplaces.

Among the technological factors, as in the case of OI_1 , the variable introduction of innovations in the market provides a positive relationship, as well as the use of protection: registering useful models, with the patent application variable being somewhat less significant.

As in the case of OI_1 , regarding the obstacles or barriers to innovation, we see that the variable that refers to not carrying out innovations as they are not needed as a result of lack of market demand, had a very significant influence. The variable lack of qualified personnel was found to be something significant.

Again, the size of the company has a positive influence on the possibility of introducing innovation of this type. This responds to a greater need on the part of larger companies to maintain a level of work organization and an organizational structure appropriate for the size of the company. This result is confirmed by Fariñas and López (2011) who find that the tendency to introduce OI type 1, 2 and 3 increases with the size of the company.

Regarding the variables related to public financing of moves to innovate, we observe that only public financing from central government offers a significantly positive relationship.

Regarding OIs of type OI_3 , improvement in methods of the management of external relations, as would be expected, influences companies who do outside R&D work. This is mainly due to the fact that companies demonstrate a greater capacity to improve productivity rates, as well as less uncertainty about the results and benefits of this. As in the case of IO_1 e IO_2 , training human resources and hiring external consultants are both revealed as determining factors to achieve improvements in the management of external relations of the company.

Other variables related to technological factors, such as the introduction of innovations in the market and the use of protection: registration of useful models, show a significantly positive relationship that also makes it easier to undertake new management methods for the company's relationships outside.

Regarding the variables that refer to obstacles or barriers to innovation, we see that there are differences with respect to the previous IO_1 e IO_2 , since we observed that the lack of information about the markets; the difficulty in finding partners for cooperation over innovation; or considering not to embark upon innovations as they are not needed due to lack of demand, are determining factors when undertaking this type of OI. We see also that the high costs of innovation is a significant factor.

Finally, the existence of staff specifically devoted to R&D action also has a positive influence on the adoption of methods that contribute to improving the management of external relations, as well as public financing by national government bodies and the European Union.

5. Conclusions

As can be seen by the results obtained from the model, and despite being a relevant issue in the business management of companies in general - and in particular of innovations - the study of OI has received little general attention up till now.

The lack of a widely accepted definition and the difficulties in measuring the concept of OI has undoubtedly delayed the emergence of empirical evidence regarding this type of innovation. The database used in this research (PITEC) has enabled us to surmount this problem, since it explicitly addresses the measurement of OIs, using the definition provided in the Oslo Manual.

The integration of this definition within the survey constitutes a notable advance in the follow-up of non-technological innovations, in that it enables us to produce comparable empirical evidence based on a standardized definition, widely accepted and shared internationally.

In an effort to advance in the understanding of the factors that influence the adoption of OI, a trivariate probit model was estimated to identify the determining variables in the adoption of the three different types of organizational innovation figuring in PITEC.

The results of the analysis of determinants for the adoption of OI reveal the following findings. First, the implementation of the trivariate probit model highlights

the importance of analyzing the inclusion of OI as an action that is carried out inter-dependently among the three types of organizational innovation. This fact assumes that the analysis of these innovations must take into account what happens to the rest of the organizational decisions.

It can be affirmed that OIs are positively influenced by the size of the enterprise, the introduction of ICTs, the procurement of machinery, software and hardware; the introduction of innovations in the market; the use of protection; applications for patents (to a lesser extent); the qualifications of available human resources; the need to have expert external consultants; and companies' need for public financing to cover the costs of bringing in non-technological innovation.

The results show that the variables that reinforce the learning capacity of organizations significantly influence the adoption of the three types of OIs. This result suggests that the interdependence between the different types of organizational innovation responds to the existence of elements that foster the introduction of innovations transversally.

This article constitutes a starting point to continue moving forward in the research into OI. The future lines of research that are proposed involve a broader time frame in terms of the analysis of the effect of OIs, as well as a more detailed study of their determinants, paying particular attention to the introduction of innovations by sector classification (manufacturing companies and services) or the technological capacity of the company (high, medium and low level of technological capacity).

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