Determinants of open innovation in low-tech SMEs: the influence of the top management team and employees' human capital

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Abstract

This article aims to analyze the influence of top management team (TMT) characteristics and employees' human capital on the adoption of open innovation practices in low-tech SMEs. The empirical study is based on the use of structural equations from the data derived from a questionnaire applied to 95 companies in the agro-industrial sector located in the northeastern region of Colombia. The results indicate that both the TMT's diversity and coordination have a significant and positive influence on the adoption of open innovation practices. On the other hand, regarding human capital, the results indicate that the experience of the employees is a more decisive feature when implementing open innovation strategies than their level of education and training. This paper contributes to the literature by providing part of the missing microfoundations of open innovation and more strongly connecting open innovation, human capital, and TMT configuration.

Resumen

Este artículo tiene como objetivo analizar la influencia de las características del equipo de alta dirección (TMT) y el capital humano de los empleados en la adopción de prácticas de innovación abierta en las pymes de baja tecnología. El estudio empírico se basa en el uso de ecuaciones estructurales a partir de los datos derivados de un cuestionario aplicado a 95 empresas del sector agroindustrial ubicadas en la región noreste de Colombia. Los resultados indican que tanto la diversidad como la coordinación del TMT tienen una influencia significativa y positiva en la adopción de prácticas de innovación abierta. Por otro lado, en cuanto al capital humano, los resultados indican que la experiencia de los empleados es un rasgo más determinante a la hora de implementar estrategias de innovación abierta que su nivel de educación y formación. Este artículo contribuye a la literatura al proporcionar parte de los microfundamentos faltantes de la innovación abierta y al conectar de manera más sólida la innovación abierta, el capital humano y la configuración de TMT.

Keywords: Open innovation; SMEs; Determinants; TMT diversity; TMT coordination; Employee education and training; Employee experience

Introduction

Innovation has been recognized as a key factor for the competitive development of companies. As a result of innovation processes, companies introduce new or improved products (goods or services), new production processes, new marketing techniques and even new organizational management strategies into the market (OECD, 2005). All these elements help the company to differentiate itself, access new markets and, in general, increase its levels of competitiveness.

In the field of innovation management, an approach that has gained strength is that of Open Innovation (OI). This approach, introduced by Chesbrough (2003), assumes that during the development of their innovation processes companies can and should use not only internal ideas, but also existing knowledge in their environment. Similarly, it highlights that companies can use different ways to efficiently exploit their technological capabilities and introduce new products and processes to the market (West & Bogers, 2017).

Studies on the open innovation approach have grown in the last decade, resulting in an important body of literature on the analysis of the characteristics, determinants, and effects of this strategy on business performance (Moretti & Biancardi, 2020). However, most of this literature has focused on the analysis of large companies, belonging to technology-intensive sectors, and located in economically developed contexts (Tchuinou et al., 2021). The study of these processes in small and medium-sized companies (SMEs), from traditional sectors that are not very intensive in R&D, has received relatively less attention. This last aspect is surprising if one considers the importance of SMEs in the industrial ecosystems of most economies and the fact that recent research has recognized the relevance of the adoption of OI strategies in this group. Thus, for example, in the Latin American and Caribbean region, SMEs represent more than 99% of companies and generate close to 60% of all jobs (OECD & CAF, 2019). However, their contribution to GDP is relatively low, which reveals deficiencies in their productivity levels.

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Along these lines, several authors have highlighted that OI may become an important strategy to overcome typical weaknesses of SMEs (limited resources, little information on markets and technologies, difficulty in accessing external financing, etc.), while at the same time, they point out that its implementation may be favored by some characteristics of this type of company, such as its flexibility, informality and risk taking (Spithoven et al., 2013).

However, to effectively implement OI strategies, companies need to develop specific skills that allow them to leverage resources and capabilities with external actors, as well as an organizational culture favorable to collaboration. While researchers have identified good practices on how to achieve these changes in the context of large companies, knowledge about the factors that favor the adoption of OI strategies in SMEs is still scarce. In this sense, the lessons learned from the analysis of large companies cannot be directly transferred to SMEs, considering that the latter represent unique contexts in terms of their resource endowment, staff skills and the close connection between the management team and the company's strategy (Brunswicker & Vanhaverbeke, 2015). An explicit focus on the analysis of the determinants of OI in the context of SMEs is therefore justified.

In line with the above, the objective of this article is to analyze the determinants of the adoption of open innovation practices in SMEs in traditional manufacturing sectors. Starting from the consideration of the aforementioned aspects, the research focuses on the effect of individual determinants associated with the characteristics of top management team (TMT) and employee human capital characteristics. By doing this, the study aims to correct an existing bias in the current literature that prioritizes the R&D capacity of companies as the most important determinant of open innovation processes; a bias which has left the study of the mechanisms through which non-technology-intensive SMEs acquire and exploit the knowledge available in the environment in the background.

With regard to TMT, previous studies have indicated the influence that the manager and his management team have in defining the business strategy. In fact, some research has described how the ability of leaders to make decisions in a coordinated way, their diversity, and even their complementary capacities influence the innovative performance of the organization (Röd, 2019). Curiously, little has been analyzed on the influence of these elements on the adoption of open innovation strategies by SMEs, which is surprising if one considers that these processes do not arise spontaneously. Opening the company for the development of innovations requires strategic planning and a suitable work environment, which requires leadership and commitment from decision-makers (Najar and Dhaouadi, 2020). Along these lines and based on the contributions of the upper echelon theory (Hambrick & Mason, 1984), we suggest that the adoption of open innovation practices depends on the diversity and coordination of the TMT.

The other factor that is analyzed as a possible determinant of OI in this investigation is related to employee human capital, that is the stock of knowledge that gives an individual the ability to perform labor (Becker, 1962). This stock of knowledge is obtained through education, training, experience, etc. Anchored in the absorption capacity approach, various authors have pointed out that the existing knowledge base in the company is a key element to identify, assimilate and exploit the relevant knowledge existing in the environment (Cohen & Levinthal, 1990). In other words, the ability of a company to acquire and exploit external knowledge is greater in those fields in which it has related prior knowledge or experience (Vega-Jurado et al., 2017). The foregoing, taken into the context of this study, would suppose that the level of education, training and experience of employees may be an important determinant for the adoption of OI practices, particularly in the case of SMEs in traditional sectors for which the development of R&D activities is not the usual strategy to expand your knowledge base.

To address the analysis of the aforementioned aspects, this research takes as a basis the information derived from a questionnaire applied to 95 SMEs in the agro-industrial sector of the northeastern region of Colombia (South America). The questionnaire collects information on the adoption of open innovation practices by companies, as well as key aspects related to the two factors analyzed in this study as possible determinants: TMT characteristics and the capabilities of the employees. To contrast the research hypotheses, a structural equations modelling was carried out, considering the latent nature of the analyzed constructs.

The rest of the article is structured as follows: in the next section the literature is reviewed, and the hypotheses of the study are presented. Subsequently, the methodology, data, variables, and estimation technique used in the research are described. The fourth section presents the results, and the last section presents the conclusions and proposals for future lines of research.

2. Literature review and hypothesis development

Since Chesbrough (2003) coined the term open innovation, various researchers have analyzed the characteristics of these processes in the business environment. In this field, research on SMEs has gained significant momentum as shown in recent review articles on this topic (Hossain & Kauranen, 2016; Tchuinou et al., 2021). Studies have indicated that, although SMEs have some restrictions in terms of resources and capacities compared to large companies, the adoption of OI practices are not an unusual phenomenon in this group. In fact, the scarcity of resources and internal technological assets become a relevant motivation for SMEs to implement OI strategies (Chesbrough, 2010; Vega-Jurado et al., 2015). The research has also made it clear that, due to the substantial differences between large companies and SMEs, it is necessary to deepen the specific analysis of the factors that influence the development of the OI strategy in the latter (Hossain & Kauranen, 2016).

Tchuinou et al. (2021) propose, based on a review of the literature, a conceptual framework in which they point out that the implementation of open innovation practices in SMEs is determined both by business factors and by characteristics of the industry and the environment in which the company competes in. Among the business factors, the focus of this research, the authors highlight two elements in particular: a) TMT characteristics and b) the skills of employees.

As with the first element, the upper echelons theory (Hambrick & Mason, 1984) proposes that the strategic decisions of a company are largely determined by the behavioral factors, values, and antecedents of the dominant coalition, that is, the top management teams (TMT). This team monitors the environment and interprets the situations faced by the organization based on their experiences, cognitive biases, and perceptions (Hambrick, 2007). The dominant coalition that controls an SME changes its interests, motivations, and behaviors, including the propensity to adopt OI practices. The decision to include external partners in the innovation process depends on the behavioral characteristics of the main decision makers of the organization (Vicentin et al., 2021; Najar and Dhaouadi, 2020) and the scope of search activities depends especially on internal variables such as aspiration and strategic intention.

It is expected, therefore, that the characteristics of the TMT determine how open the SME is to external knowledge networks for the development of innovation processes. Within the framework of the upper echelon theory, two key characteristics that have been analyzed in relation to TMT are diversity and team coordination (Röd, 2019; Daspit et al., 2014; Eisenhardt & Martin, 2000). Diversity is related to the existence of different frames of reference among the members of the TMT, which can condition the way in which situations are analyzed and decisions are made. This diversity can be derived both from demographic differences (race, age, gender) and from variations in terms of educational or professional background (Mathieu et al., 2008). The heterogeneity between the members of the TMT provides the team with different types of knowledge and decision-making styles, as well as a greater variety of professional perspectives (Koryak et al., 2018). These aspects, in the case of the adoption of OI processes, can act as catalysts by facilitating a broader and more diverse search for solutions abroad. In fact, Zahra and George (2002) postulate that a company needs a diverse set of specialized knowledge to effectively address the processes of seeking and acquiring external knowledge. Business projects are not only analyzed from one perspective, but also tend to be projected on different fronts to take better advantage of opportunities in certain contexts. In this line, a management team with diverse capacities, experiences, or knowledge in both scientific and non-scientific areas (finance, marketing or international) is more likely to promote the adoption of an OI strategy in the organization. Considering the above, the following hypothesis is proposed:

H1. The TMT's diversity is positively related with the adoption of OI practices in SMEs.

To better understand the influence of TMT configuration on organizational performance, recent studies have focused attention on the analysis of the aspects that affect the processes that occur within the team, improving its efficiency and effectiveness in decision-making (Knight et al., 1999). One of these elements has to do with the coordination of the TMT (Vega-Jurado et al., 2019). A coordinated management team has better managerial performance and transmits security to the knowledge base in the company. Coordination is a characteristic

that streamlines decision-making processes, synthesizes different points of view, and allows correcting errors in a timely manner to achieve the objectives set (Daspit et al., 2014). Coordination involves integrating various tasks and operations of a group in a timely manner so that satisfactory overall performance can be achieved. Eisenhardt and Martin (2000) highlight coordination as an important factor for the effective exchange of knowledge and experiences, both internally and externally. In the context of OI processes, a coordinated TMT facilitates decision-making, as well as the integration of different points of view, which would allow the definition of a broader knowledge search strategy. In this sense, the following hypothesis is proposed:

H2. The TMT coordination is positively related with the adoption of OI practices in SMEs.

The second element pointed out by Tchuinou et al. (2021) in its conceptual model as a determinant of OI in SMEs is the employee human capital. The literature on innovation has highlighted the relevance of human capital for the participation of companies in collaborative activities. Teirlinck and Spithoven (2013), for example, argue that OI practices, such as research cooperation and R&D outsourcing, require internal employees trained and capable of developing R&D activities. The foregoing is reminiscent of the notion of absorptive capacity, which indicates that for a company to acquire and exploit external knowledge, it must have an internal knowledge base in related areas. According to Cohen and Levinthal (1990), the organization's ability to evaluate and utilize outside knowledge is largely dependent on prior investment in the development of its constituent, individual absorptive capacities (Cohen & Levinthal, 1990). As such, employee knowledge bases can be important determinants of a firm's propensity to adopt open innovation practices.

The firm's knowledge base is configured from various factors, among which we can find the development of R&D activities, as well as the level of education, training and experience of the employees. In fact, previous research carried out in the context of companies that are not very intensive in R&D have highlighted the role of the skills of employees and their professional experience as catalysts for the acquisition of relevant external knowledge (Vega Jurado et al., 2017).

Regarding employee training, Gray (2006) found that this variable significantly affects the acquisition and assimilation of external knowledge in SMEs. Similarly, Romijn and Albaladejo (2002) highlight the importance of specialized knowledge and training in areas associated with engineering and technology as a necessary condition for technological learning and the achievement of innovative results. Tapscott (2012) also highlights the importance of training and qualification of employees for the development of innovation processes. This author points out that it is the employees who contribute to the development of innovations and identify the moment when external collaboration is required to solve company problems. Considering the above, the following hypothesis is formulated:

H3. Employee training and education is positively related with the adoption of OI practices in SMEs.

Additionally, some studies have highlighted that the firm's knowledge base is configured not only based on the level of education or training of the workers, but also thanks to their internalized experiences, particularly when analyzing the case of companies that operate in non-science-based sectors (Viding, 2006). Thus, for example, Souitaris (2002) finds that, in addition to the proportion of university graduates, previous experience in other companies represents a variable strongly related to innovation. Tripsas and Gavetti (2000) specify that the experience that workers have can be an aspect that helps to value the knowledge available in the environment. Years of experience in a company or in a specific sector constitute an important source of information and knowledge about the players that operate in the market and can be key when identifying potential partners or defining collaboration agreements. In this sense, the following hypothesis is proposed:

H4. Employee experience is positively related with the adoption of OI practices in SMEs.

3. Methodology

3.1 Data

The empirical study is carried out based on the information collected through a survey applied to SMEs in the agro-industrial sector located in the department of Norte de Santander (Colombia, South America). The population under study was obtained from the Compite 360 platform, which gathers the data of the companies registered with the chambers of commerce of 40 cities in Colombia. 119 agro-industrial SMEs for the specified region are registered on said platform, to which the information collection instrument was sent.

The questionnaire was designed taking into account the key aspects of this research associated with the adoption of OI practices by companies, as well as the characteristics of TMT and the knowledge base of the employees. Before applying the questionnaire, a pilot test was carried out to ensure that the questions were clearly understood by the respondents. The questionnaire was applied virtually, by telepho-

ne and email monitoring, during the first semester of 2020. At the end of the process, 95 valid surveys were obtained, representing 79.8% of the population under analysis. Table 1 shows general characteristics of the final sample obtained.

Table 1. Distribution of the sample by size and seniority.

		Number of firms
Size	Small (10-50 employees)	90
	Medium (51-200 employees)	5
Age of the company	1 – 10 years	75
	11 – 20 years	12
	21 – 30 years	4
	More than 30 years	4

3.2 Variables and measures

For the development of this research, five fundamental constructs are taken into consideration: open innovation, TMT diversity, TMT coordination, employee training and employee experience. All these constructs represent latent variables that are measured through a series of items captured on a Likert scale. According to Battistella et al. (2017), one way to analyze open innovation is through the practices that companies adopt to interact with external actors in their innovation processes. In this sense, the literature has highlighted that such practices can be implemented through inbound processes (outside-in) or outbound (inside-out). The former practices are associated with the acquisition and exploitation of external knowledge, while the latter are associated with the search for new channels to exploit the internal technological capabilities of the company (Dahlander & Gann, 2010). Taking into account the objectives of this research, the OI construct is analyzed considering basically the inbound processes. In this sense, the questionnaire posed various questions that capture the degree of adoption of different OI inbound practices. For this, the contributions of previous works that identify three key practices were taken into account: a) external acquisition of knowledge through contracting processes, b) collaboration with external actors, and c) co-creation processes with customers (see Table 2). Taking into account these contributions, the questionnaire was configured with the items described in Annex 1.

Table 2. Constructs and reference articles.

Construct	Dimensions	References
Open Innovation	Knowledge acquisition	Brunswicker et Vanhaverbeke (2015); Triparthi (2016)
	Collaboration	Spithoven et al. (2013); Jang et al. (2017); Battistela et al. (2017)
	Co-creation with business customers	Haukipuro et al. (2018); Morgan et al. (2019); Theyel (2013)
TMT diversity		(Nielsen, 2010); Vega-Jurado et al., (2019)
TMT coordination		Vega-Jurado et al., (2019)
Employee training		Leiponen (2005); Natalicchio et al., (2018); Spithoven et al. (2013); Teirlinck and Spithoven (2013); Vega-Jurado et al., (2017)
Employee experience		(Leiponen, 2005; Freel, 2005); Vega-Jurado et al., (2017)

Source: Authors' own elaboration

Regarding the characteristics of the TMT, two constructs were defined: TMT diversity and TMT Coordination. To measure the first construct, various items were used that capture various dimensions of diversity (educational background, diversity of experiences, professional background, age) in line with other measures previously applied in the literature (Nielsen, 2010). TMT coordination, meanwhile, was evaluated through a series of items that capture the degree to which TMT members work in a coordinated manner for decision-making and report less conflict (Vega-Jurado et al., 2019). A description of these items can be found in Annex 1.

Finally, the stock of knowledge of the employees is measured by analyzing two dimensions: education and experience. This approach is in line with previous research (Vega-Jurado et al., 2017) and is

relevant to analyze the firm's absorptive capacity beyond the development of R&D activities, which, in the case of companies that are not intensive in technology is not the most appropriate indicator. In this sense, the questionnaire included a series of items that inquire about the level of education and training of the employees, as well as the experience accumulated by them both in the company and in the sector where it operates (see Annex 1).

All the items used in this research are measured on a 7-point Likert scale that captures, depending on the case, the degree of agreement on certain statements or the frequency with which certain practices are carried out.

Based on the previous constructs, the following model is estimated (see Figure 1)

Figure 1. Analysis model.
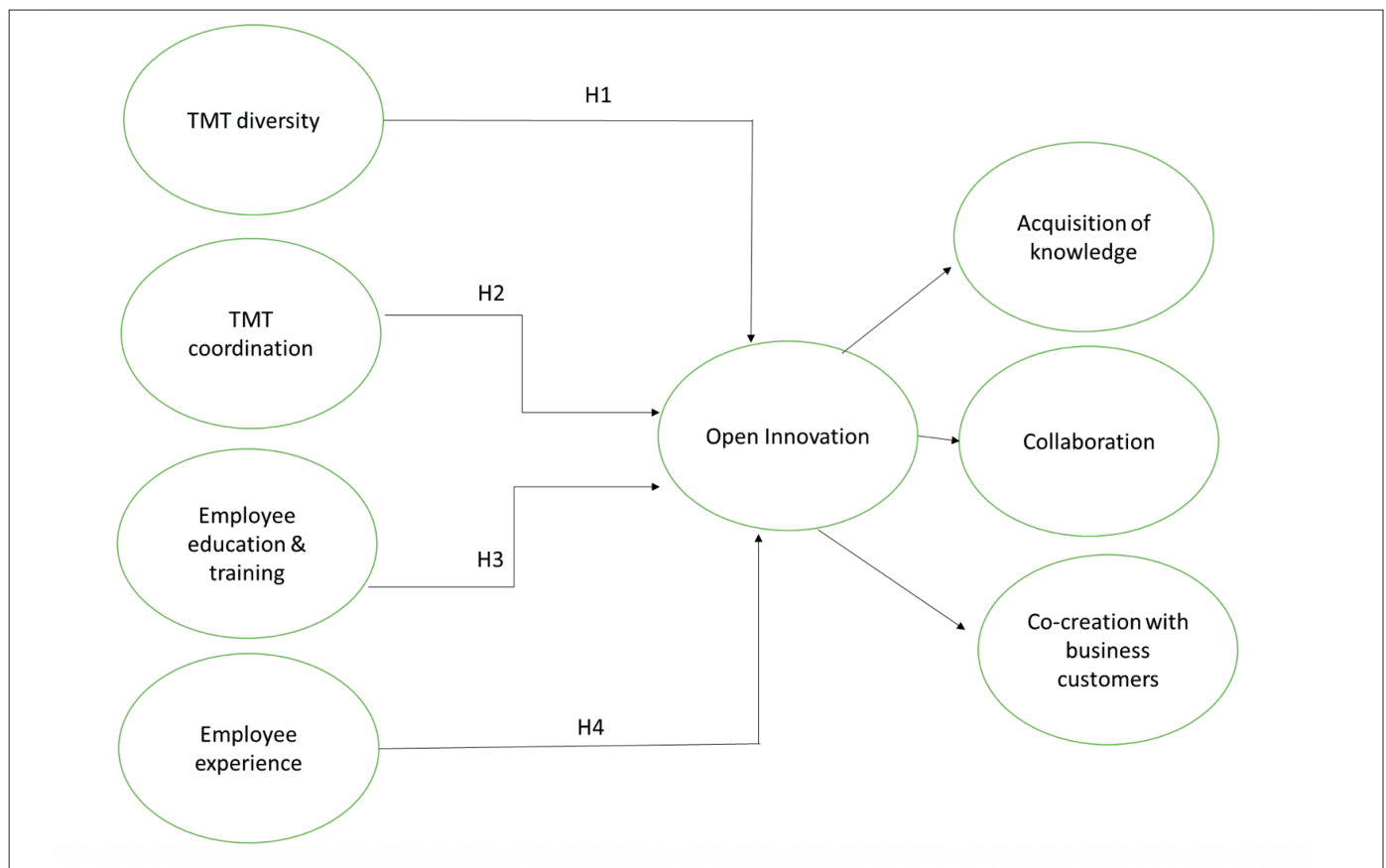
3.3 Estimation technique

The analysis of the proposed model is carried out using structural equations modeling. This analysis technique is used to evaluate unobservable latent constructs, such as those raised in this research. Using the Structural Equations Model (SEM), the predictive approach of classical econometric multiple regression technique can be combined with the psychometric approach, based on the measurement of latent variables through multiple observed variables (indicators), applying factor analysis.

In the SEM, two types of models must really be considered (Vega-Jurado et al., 2017):

- The measurement model, that is, the one that results from applying the factorial analysis technique to determine the factorial loads of the observable variables (indicators) in relation to the latent variables (constructs).

- The structural model, which allows the analysis of causal relationships between a set of independent and dependent constructs.

The literature distinguishes between two types of structural equation models: a) models based on covariance, and b) models based on variance. The choice between one or the other model is determined mainly by the objective of the research, since the first studies the structure of the observed variables to test or confirm an assumption, while the second model aims to predict the effects of the variables. The variance-based PLS structural equation models (PLS-SEM) uses the available data to estimate the relationships of the variables in the model in order to minimize the error terms, that is, the residual variance of the endogenous constructs. The PLS model is less restrictive with respect to sample size and data characteristics and can be used for both explanatory (confirmatory) and predictive (exploratory) investigations (Henseler et al., 2016). Taking into account these characteristics, the PLS estimation method is the one chosen in this investigation.

4. Results

As noted in the previous section in structural equations modeling, the measurement model specifies the relationship between the observable variables and the underlying constructs. In this sense, the first step is to corroborate the suitability of the selected indicators for measuring the constructs, that is, if the observable variables allow the hypothesized construct to be identified. For this, all the constructs of the measurement model are simulated as reflective constructs, since we consider that the determinant objects of study exemplified in the questions included in the questionnaire are those that cause the underlying construction and not the other way around. Considering the above, in the analysis of the measurement model it is possible to identify some items of the survey that do not meet the statistical criteria considered necessary to be included as key elements in the measurement of the construct. Tables 3 and 4 show the results of this evaluation, highlighting that the defined constructs, both those of the first order and those of the second order, are valid and reliable.

Table 3. Validation of first order constructs.

| First order constructs	Cronbach's alpha	Composite reliability	Average variance extracted (AVE)	Item	Factorial load
TMT diversity	0.791	0.868	0.627	DIVER1***	0.692
				DIVER2***	0.710
				DIVER3***	0.765
				DIVER4***	0.644
TMT coordination	0.723	0.878	0.782	COOR1***	0.793
				COOR3***	0.714
Employee education & training	0.853	0.898	0.688	FORM1***	0.424
				FORM2***	0.773
				FORM4***	0.978
				FORM5***	0.820
Employee experience	0.880	0.912	0.677	EXP1***	0.687
				EXP2***	0.546
				EXP3***	0.880
				EXP5***	0.825
				EXP6***	0.882
Acquisition of knowledge	0.810	0.870	0.577	ADQUI1***	0.683
				ADQUI2***	0.834
				ADQUI3***	0.879
				ADQUI5***	0.780
				ADQUI6	0.586
Collaboration	0.77	0.853	0.595	ACTOR3***	0.738
				ACTOR4***	0.607
				ACTOR5***	0.872
				ACTOR7***	0.842
Co-creation with business customers	0.931	0.956	0.879	CLIENT1***	0.949
				CLIENT2 ***	0.938
				CLIENT4***	0.926
*** 99% significance					

Table 4. Validation of the second order construct.

Second order construct	Cronbach's alpha	Composite reliability	Average variance extracted (AVE)	First order constructs	Factorial load
Open innovation	0.873	0.897	0.472	Acquisition of knowledge ***	0.855
				Collaboration***	0.809
				Co-creation with business customers ***	0.749
*** 99% significance					

Figure 2 presents the results of the structural model. The individual path coefficients of the PLS-SEM represent the standardized beta coefficients resulting from the least squares estimation. The hypotheses were tested by quantifying the significance of the structural equation paths with bootstrapping as a resampling method and examining the absolute values of the hypothesized relationships. A metric that serves to judge the structural model is the coefficient of determination of endogenous constructs (R^2), which reflects the amount of variance of the construct that is explained by the predictor variables. For the analyzed model, this indicator is 0.56, which reflects a substantial value (Chin, 1998) and implies that TMT diversity and TMT coordination, as well as the experience of the employees explain 56% of the adoption of open innovation practices.

Figure 2. PLS-SEM results.
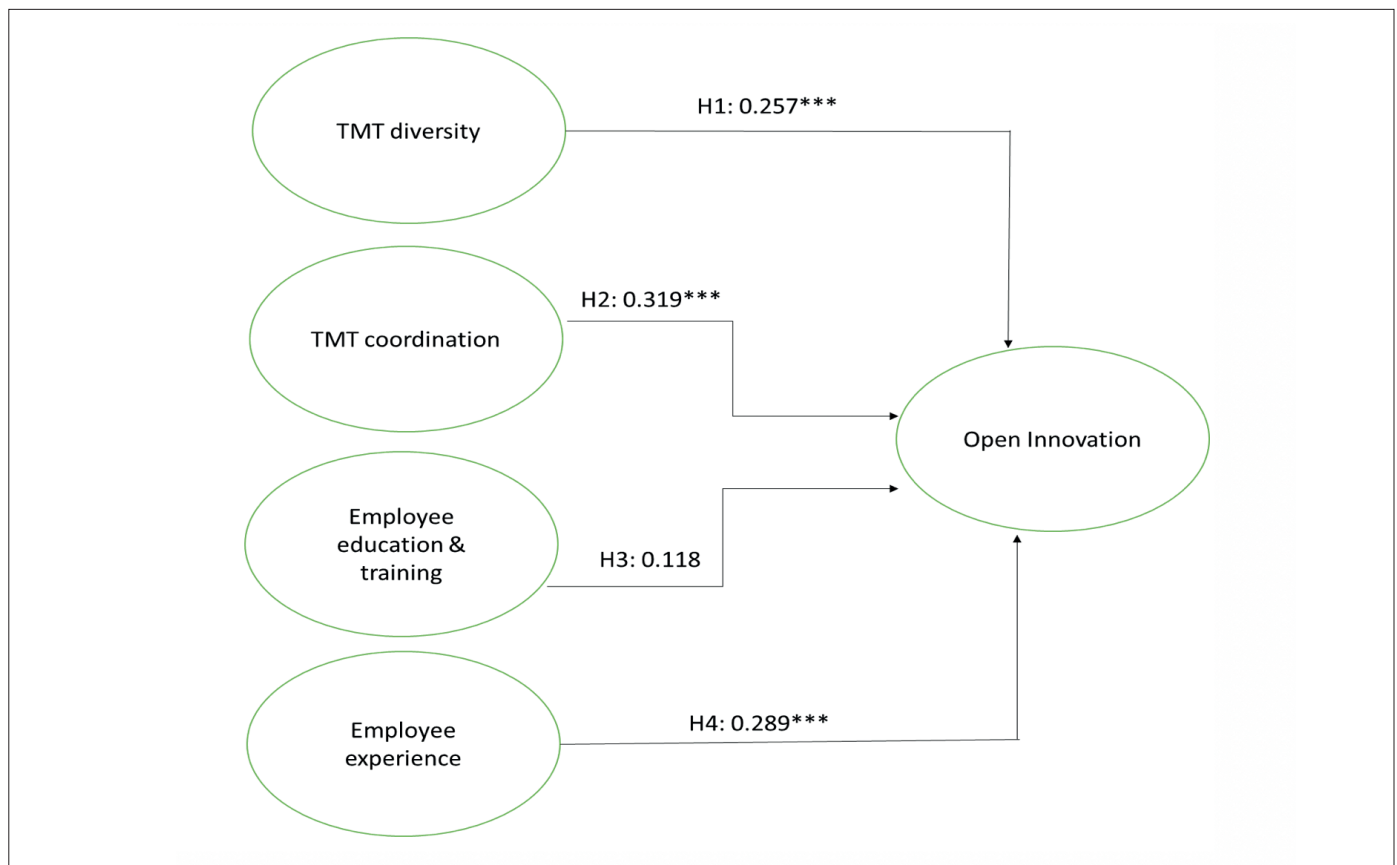
As observed, the results show that both TMT diversity (0.257; p <0.01) and TMT coordination (0.319; p <0.01) are positively and significantly related to the adoption of open innovation practices, confirming hypotheses 1 and 2.

Regarding the effect of human capital, the results show that the experience of the employees is positively and significantly related to the adoption of open innovation practices (0.289; p <0.01); while the level of education and training does not present a significant relationship.

In this sense, there is evidence that supports hypothesis 4, but hypothesis 3 cannot be confirmed.

5. Discussion and conclusion

The main purpose of this research was to analyze the determinants of open innovation processes in SMEs in traditional manufacturing sectors, addressing the analysis of factors related to the TMT characteristics and the capabilities of the employees. It focuses on these factors

in order to overcome the existing bias in the literature based on the study of a firm's R&D efforts as the main determinant of open innovation. Although previous studies support the importance of R&D, the evidence is limited in most cases to large companies or companies belonging to technology-intensive sectors. In this sense, it is not possible to extrapolate these results to traditional SMEs, which, despite not investing significantly in R&D activities, have shown to implement collaborative practices for the development of their innovation processes (Hossain & Kauranen, 2016).

Considering the above and starting from the contributions developed in the framework of the upper echelons theory (Hambrick & Mason, 1984), the effect of two TMT characteristics is empirically evaluated: its diversity and its coordination. The results indicate, in line with the hypotheses raised, that the TMT configuration exerts a significant influence on the adoption of open innovation practices. In the first place, it is confirmed that a diverse management team in terms of their educational level, professional experience, age, and area of training, has a positive impact on open innovation. This result is in line with previous research that indicates that a heterogeneous TMT is more likely to stimulate the development of collaborative innovation practices because they have a greater cognitive base and a broader network of relationships (Vicentin et al., 2021). Among the benefits of a diverse management team are the diversity of knowledge and skills, which can promote creativity and innovation by allowing a broader search for knowledge and opportunities in the company environment.

Similarly, the results highlight that TMT coordination also positively influences open innovation. This second characteristic of the management team has been analyzed more recently in the literature in order to identify the mechanisms through which TMT members make decisions more efficiently. Previous research has indicated that a degree of coordination of the TMT is important to reduce friction between team members and tend to reach agreements in the design of the organizational strategy (Vega-Jurado et al., 2019). In the framework of the analysis carried out in this research, the coordination of the TMT is shown as a relevant factor to stimulate open innovation practices, most likely because it facilitates decision-making regarding the selection of partners, as well as the definition of the governance model to manage the relationship (collaboration, outsourcing, etc.).

On the other hand, as with employee human capital, the results corroborate the importance of the experience of the employees as a determinant of open innovation, but contrary to the hypothesis, their level of education and training did not turn out to be significant. These results show an interesting pattern. In the first place, and in line with previous studies, the experience that employees have both in the company and in the sector where it operates, constitutes a key factor to stimulate collaborative innovation processes. This may be due to the fact that, the more experience, the greater the absorptive capacity of the workers (Leiponen, 2005), thus facilitating the exploitation of relevant external knowledge. If employees know the environment where they carry out their operations, as well as the characteristics of their organization (culture, management practices, etc.), it is easier to identify the potential partner and manage the collaborative process.

On the other hand, the non-significance of the level of training suggests that, at least in the context analyzed, the level of qualification and training of workers is not a key factor to promote open innovation processes. Along these lines, Vinding (2006) had already suggested that the effect of the educational level of workers on the propensity to innovate was contingent on the sector where the company operates, being more significant in the case of high technology sectors. Similarly, authors such as Leiponen, (2005) and Freel, (2005) indicate that, in some cases, more than university training, technical competence or accumulated experience become an essential factor for the exploitation of knowledge. In this sense, it can be concluded that in the case of low-R&D intensity SMEs, the experience of their workers is a more decisive feature when implementing open innovation strategies than their level of training. This result may also be the product of the specific way in which SMEs implement open innovation processes. Spithoven et al. (2013), for example, pointed out that while large companies tend to collaborate with research centers and R&D labs, SMEs orient their open innovation strategy more towards collaboration with customers and suppliers. In this sense, it would not require a very high level of training on the part of the workers to exploit such collaboration, but rather greater technical competence or knowledge of the market, skills that can be developed as a result of professional experience in the company and in the sector.

The results of this research have important theoretical and practical implications. From a theoretical point of view, the need to deepen the analysis of the determinants of open innovation in SMEs has been highlighted, considering that the particular characteristics of this type of companies mean that the contributions generated in the literature on large companies are not directly applicable. In this line, the importance of the factors associated with human capital antecedents as determinants of the adoption of open innovation practices in SMEs is corroborated, thereby strengthening what has been indicated in recent research in relation to the need to deepen the analysis of "the human side" of open innovation (Ahn et al., 2017; Natalicchio et al, 2018). More generally, our findings contribute to the literature by providing part of the missing microfoundations of open innovation and more strongly connecting open innovation, human capital, and TMT configuration. Our theory suggests that SMEs with a diverse and coordinated TMT and with a more experienced workforce are at an advantage with respect to engaging in open innovation, as they can exploit existing diversity and the firm's knowledge base. As such, our findings may help guide recruitment practices in firms that wish to support or expand open innovation strategies.

From a practical point of view, the results can serve as a guide for the design of strategies aimed at strengthening SMEs. The configuration of diverse management teams, as well as the definition of mechanisms that facilitate better coordination of the same, represent key aspects to stimulate the development of innovation activities in SMEs. In times of disruptive changes and high uncertainty in the market, SMEs must bet more strongly on innovation and, in particular, on greater collaboration with external actors to develop these processes more efficiently. In this sense, it is necessary to configure diverse and highly coordinated management teams. Therefore, it should be ensured

that the managers who join the organization contribute knowledge and different frameworks of thought, while helping to expand the company's network of contacts based on the professional experience acquired in previous jobs. Similarly, it is necessary to implement strategies that facilitate communication between members of the management team and promote greater coordination in decision-making. Additionally, SMEs should seek mechanisms that allow them to capitalize on the accumulated experience of their workers in favor of the development of open innovation processes. The knowledge that workers have about the market and the context of the organization constitutes a relevant asset for the selection of partners and the management of collaboration agreements.

Finally, it is necessary to highlight some limitations of the study. First, the data used is cross-sectional in nature, which only allows us to analyze the situation at a specific moment in time and not carry out longitudinal analyses. Likewise, the measures related to the characteristics of the management team and the capabilities of the employees are based on the perception of the Director or Manager of the company, who answered the survey. Although previous studies have used similar methodologies, it would be interesting to complement these analyses with information derived from different respondents (for example, different members of the management team or workers at different hierarchical levels).

In addition to trying to correct the methodological limitations mentioned above, future research may focus on the analysis of other possible determinants of open innovation in SMEs. Along these lines, following the model proposed by Tchuinou et al. (2021), future works may explore the effect of organizational factors (organizational structure and culture, organizational capacities, knowledge infrastructure, etc.), as well as factors related to the product (stages of product development) and the industry in which the company operates.

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Annex 1. Items included in the questionnaire

Items for TMT diversity	Coding
The members of the top management team have knowledge related to different disciplines.	*DIVER1*
Members of the top management team have different professional backgrounds.	*DIVER2*
The members of the top management team have a diverse profile in terms of training, experience, age.	*DIVER3*
Members of the top management team differ in their educational level.	*DIVER4*
Items for TMT Coordination	
The top management team works in a coordinated manner	*COOR1*
The top management team has few misunderstandings regarding the distribution of responsibilities.	*COOR2*
The top management team generally accomplishes the task efficiently and effectively.	*COOR3*
Items for employee education and training	
Company employees have the education and training necessary for the development of their functions	*FORM1*
Compared to companies in the sector, our employees have a higher level of education and training	*FORM2*
The lack of qualified personnel is a major weakness of the company	*FORM3*
The company has a great capacity to retain its qualified staff	*FORM4*
The company actively promotes the training, updating and training of employees	*FORM5*
Items for employee experience	
The company's employees have extensive experience in the development of the company's own activities	*EXP1*
Company employees are well aware of market behavior	*EXP2*
Employees have acquired most of their experience in the company	*EXP3*
Employees have acquired most of their experience in other companies in the sector	*EXP4*
The average seniority of the company's employees exceeds the average of the companies in the sector	*EXP5*
Compared to the competition, our employees have more experience	*EXP6*
Open Innovation: Acquisition of knowledge	
In this company it is considered that the technology that has been purchased can create new opportunities	*ADQUI1*
The company is willing to buy the intellectual property of other companies to support internal development	*ADQUI2*
In the company it is believed that it is beneficial to determine systematic and formal ways of searching for external knowledge and technology.	*ADQUI3*
To ensure the development of new products / processes, in this company the knowledge of other companies is usually acquired	*ADQUI4*
In this company external knowledge / technology is considered to contribute significantly to innovation.	*ADQUI5*
It is believed that investing in a new company could generate new knowledge / technology for the company.	*ADQUI6*
Open Innovation: Collaboration with external actors	
In this company, R&D services are acquired from knowledge institutions such as universities, institutes, laboratories, among others.	*ACTOR1*
With the aim of acquiring new technologies and knowledge, this company cooperates with institutions such as universities, institutes, laboratories, among others.	*ACTOR2*
In this company, knowledge is acquired through informal relationships with researchers from universities, R&D centers and institutes.	*ACTOR3*
In this company, knowledge is acquired through mentoring with graduate students	*ACTOR4*
With the aim of acquiring new technologies and knowledge, this company cooperates with high-tech companies	*ACTOR5*
In order to acquire new technologies and knowledge, this company cooperates with competitors	*ACTOR6*
With the aim of acquiring new technologies and knowledge, this company cooperates with consulting companies	*ACTOR7*
Open Innovation: Co-creation with business customers	
Customers / users participate in the process of developing new products / services	**CLIENT1**
Products / services are generally developed in light of customer wishes and suggestions	**CLIENT2**
To acquire new knowledge / technology, cooperate with customers	**CLIENT3**
Users participate in the process of testing new products / services	**CLIENT4**