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Profiles of human capital and strategic technological decisions on turbulence environment

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Abstract: The objective of this article is to examine the absorptive capacity in the technology industry and aspires to recognize how firms can manage their strategic decisions in the turbulence contexts. In particular, we examine how organizations can strengthen their organizational contexts in order to absorb knowledge. From the knowledge management literature, this investigation extends our perception of the relationship between the human capital profiles (organization, research and development unit, and recent incorporations) and technological decision-making. Through the SEPI Foundation, a balanced panel of 1,220 Spanish industrial companies has used that answer to the Survey of Business Strategies (SBS) for a three-year period, which signifies a total of 3,660 cases. The principal finding is the presence of high levels of human resources to understand a decision efficiency process. It also highlights its relationship to the firm's technological committee. These contributions are notable for both researchers and practitioners. It could be stimulating to expand the study to the association between human capital profiles and other strategic technological decisions, as the preparation of an innovation plan or the measurement of innovation performance.

Key words: Knowledge Management, Absorptive Capacity, Turbulence Environment, Human Capital, Innovation.

1. Introduction

The dynamism in the modern environments complicates, in large measure, the maintenance of the competitiveness. Organizations that do not possess the necessary source of knowledge to innovate resort to external sources (Spithoven *et al.,* 2011; Chesbrough, 2012) and must resolve how to renew their knowledge with the purpose of updating their innovative potential (Wang and Han, 2011). In this sense, absorptive capacity is highly connected with the firm's competitive environment. This is because, during knowledge exploration, the organization interacts with its environment and brings in potentially useful knowledge (Aribi and Dupouët, 2016).

To the extent, the environment is more dynamic and unstable the validity of useful knowledge will be less and the organization will bear greater difficulties to take advantage. In the first place, being able to find it quickly and, secondly, being able to assimilate it properly. A firm's absorptive capacity does not simply depend on the organization's direct interface with the external environment (Cohen and Levinthal, 1990). These authors suggest that it also depends on knowledge transfers across and within subunits.

During the transformation, in order to gain access to the necessary complementary knowledge in the environment, firms must set specific channels to external knowledge sources (Aribi and Dupouët,

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2016). The environmental turbulence is a dynamic, unpredictable, expanding, fluctuating environment (Khandwalla, 1977). Under high rate of market turbulence, orientation towards learning facilitates firms to increase organizational innovativeness and performance (Baba *et al.,* 2017). Therefore, the role of human capital is critical to organizations in turbulence contexts.

There is a lack of research on the absorptive capacity literature (Cohen and Levinthal, 1990; Zahra and George, 2002; Todorova and Durisin, 2007; Volberda *et al.,* 2010; Roberts *et al.,* 2012) in the turbulence conditions. Furthermore, researchers of absorptive capacity recommend it, such as Sun (2010), Datta (2012), Aribi and Dupouët (2016). To date, few studies explained absorptive capacity and its effects on a company in dynamics markets. For example, according to the study conducted by Santoro and Gopalakrishnan (2015), it shows the most technologically uncertain environments are associated positively with the implementation of external knowledge, as a component of the absorptive capacity.

To fill the aforementioned gaps, the present study seeks to answer the following three questions. The primary purpose of this research is the discovery of the relationship between the human capital and the strategic technological decisions in turbulence environment. The second motivation is driven by the next question: ‘‘the superior levels of human capital in the technology industry explains the presence of technological committee in the firm’’. The third intention is the discovery of the human capital profile more related with this internal capacity to absorb knowledge.

The article presents the following structure. First, the authors emphasize especially on the link among human capital, absorptive capacity and technological decisions, providing an appropriate working framework. Second, the empirical work is presented. Third, the debate is focused on the human capital’s profiles in the technological and turbulence situations. Finally, the more relevant implications and conclusions complete this document.

2. Human Capital and Technological Decisions

Employees perceive knowledge as the accumulation of successes and failures; without the existence of errors, the possibility of learning is also limited (García *et al.,* 2014). While the learning is an accumulative process without end, the valuable absorptive capacity depends on the establishment of goals. The firm’s absorptive capacity ceases when the objective is satisfied and thus more learning is not necessary (Pérez-Miguel *et al.,* 2017). Knowledge development through the learning process is fundamental to the emergence of new production techniques (Tortorella *et al.,* 2015). Furthermore, during turbulent organizational learning predict innovativeness (Baba *et al.,* 2017). When the complexity of knowledge increases, as in situations of turbulent and dynamic environments, more qualified employees are needed to enable the knowledge management processes.

When the company has more people, related, you might exploit more absorptive capacity. A firm’s absorptive capacity is not simply the sum of the absorptive capacities of its employees (Cohen and Levinthal, 1990). The number of people, in principle, does not have to transcend to the results of the absorptive capacity. The organizations aware of it providing the means to manage their potential.

In fact, they can decide on the employees training so that they are able to communicate new knowledge of the different external sources, as well as to recognize intangible ones. The companies can also form a managers committee to administer it, as an area and specific tasks. As well as interview workers, highly qualified human resources, where the value of the executive team is increased because the information which is absorbing them is more valuable. To integrate this information, and share it, the organization will provide knowledge to better decisions. Furthermore, as the technicians are focused, in many cases, with technological issues, this absorbed knowledge, similarly, will allow the best technological solutions.

To recognize the foundations of a company’s absorptive capacity, we center the form of communication between the environment and the firm, as well as among the subunits of the organization, and also on the character and distribution of expertise within the organization (Cohen and Levinthal, 1990). In this point, successful company decisions depend on knowledge transfer. Thus, tacit knowledge and face-to-face interactions help to dissipate the ambiguity of codified knowledge (Grandinetti and Tabacco, 2015). This kind of knowledge allows companies to engage in a number of innovation projects. Additionally, the effects of human capital

on innovation performance varies depending on the levels of technology (Buenechea-Elberdin *et al.,* 2017). The deficiency of a developed technological base is likely to have difficulties to absorb the technologies (Tsai and Wang, 2009).

In a study of cases, Aribi and Dupouët (2016) reveal the coordination role of a technology committee or small group of managers specifically gathered for the follow-up of the innovation activities. In particular, groups are more probable to apply an individual member's distributed knowledge when a majority of teammates are aware of the individual's expertise (Baumann & Bonner, 2013), and that teams are more likely to incorporate their distributed information when expertise knowledge is concentrated in one member than when it is disseminated homogeneously among members (Mell *et al.,* 2014). Thus, when top managers work nearly with engineers or other qualified employees, they understand the knowledge needs and adopt better technological decisions. Therefore, the percentage of engineers in the workforce can be associated with the business strategic decisions and, therefore, greater link with the technologies management.

Innovation performance needs the valuable role of doctors and research technicians. These professionals are trained for complex activities and, apparently, have to be more associated to take complicated decisions, thus, their presence can be more associated with turbulence contexts because organizations require workers with greater autonomy. These functions imply that the qualified workers' absorptive capacity is out of control. Therefore, the greater number of highly qualified personnel, the company interest will be greater for manage appropriately this absorptive capacity to integrate it in the organizational decision structure.

In knowledge area, the informational resources may add to the quality of team decision making and innovation (van Knippenberg and Mell, 2016). Additionally, the organizations use their positions of technological vigilance and management to form their capabilities, and subsequently, to enhance innovation outcomes (Pérez-Miguel *et al.,* 2018).

Based on previous literature, we present the first hypothesis:

H1: High levels of human capital above the industry average in the firm, which belongs to a technological industry and competes in the turbulence environment, are significant and positively related with the presence of the firm's technology committee.

Assimilation capability represents the organization's routines and processes that permit it to analyze, process, interpret and understand the information obtained from external sources (Szulanski, 1996). Along with the exploration capacity, it is associated with the potential absorptive capacity (Jansen *et al.,* 2005). Zahra and George (2002:188) indicate that the "organizational capabilities of knowledge acquisition, assimilation, transformation, and exploitation build on each other to yield absorptive capacity, a dynamic capability that influences the firm's ability to create and deploy the knowledge necessary to build other organizational capabilities". In particular, these researchers denote to the key component of knowledge assimilation is the understanding and the specific roles are interpretation, comprehension, and learning. Thus, the elements of knowledge assimilation, as a cognitive process, are conditioned by the mind of every individual.

Firms that want to adjust to a fluctuating world, employ those aspects that affect the absorptive capacity that is identified to influence in the breadth of knowledge inside the organization, preferably related to diversity, and those that establish links across the boundaries of the company (Van Winkelen and Mckenzie, 2008).

The literature of absorptive capacity is based on the existence of research and development (R&D) internal activities (Cohen and Levinthal, 1990; Todorova and Durisin, 2007; Volberda *et al.,* 2010) which take advantage of the external sources of knowledge to improve the innovation. Despite the dependence on external partners, organizations maintain its investment in R&D with the aim of generating new knowledge internally and to build the absorptive capacity for the follow-up of activities outside of its limits (Dahlander and Gann, 2010). Therefore, the role of internal R&D function within the firm is crucial to the effective absorption process. Companies with this competition look constantly to the outside to capture knowledge that can influence in the R&D projects.

Innovation highlights properly the specific role of doctors and research technicians. These groups are trained for reaching research activities and, presumably, have to be more associated to act implicitly in favor of a higher absorptive capacity. For example, technological vigilance functions

and knowledge exploration. Thus, the accumulated experience of workers assigned to this R&D function will be valuable and will result in higher absorption levels. Furthermore, the accumulated knowledge of qualified workers will result in higher absorption levels. Therefore, the greater number of highly qualified personnel in the R&D unit, the company interest will be greater to manage appropriately the absorptive capacity.

Based on previous literature, we present the second hypothesis:

H2: High levels of human capital above the industry average in the R&D unit are significant and positively related with the presence of the firm's technology management.

The literature on knowledge management considers the prior knowledge as an outstanding antecedent of the absorptive capacity at the organizational level (Cohen and Levinthal, 1990; Zahra and George, 2002; Volberda *et al.,* 2010; Batarseh *et al.,* 2017) and the diversity of these knowledge of the absorptive capacity at the individual level (Lowik *et al.,* 2017), which are achieved through the professional experiences, education and life experiences.

The capacity to assimilate knowledge is a function of the richness of the pre-existing knowledge structure (Cohen and Levinthal, 1990). The previous knowledge related influence the absorptive capacity and are fed at the same time to absorb knowledge (Nonaka and Takeuchi, 1995).

In the highly qualified personnel may be more present the bisociative and associative cognitive styles (Lowik *et al.,* 2017), that are critical to develop a strong capacity to codification of knowledge that allows them: (1) to absorb important knowledge from outside the company; and (2) to transform the knowledge absorbed so that it can be used, recodified or tacit, in the activities and internal services (Grandinetti, 2011).

The absorption is virtually a necessary part of any company's start-up phase when teams exploit their social capital to mitigate any knowledge gap that organizations frequently experience at birth (Grandinetti, 2016). In the other side, Buenechea-Elberdin *et al.* (2017) strengthen that the effect of qualified personnel, learning and entrepreneurship on innovation varies depending on the levels of technology. When companies lack a sufficiently developed technological base, they are likely to have difficulties to absorb the technologies of recruitment market (Tsai and Wang, 2009).

The learning outcome is greater when the object of learning is related to what is already known, consequently, learning is more difficult in novel domains (Cohen and Levinthal, 1990). The transformative learning process enhances assimilation and transformative capabilities (Rezaei and Darwish, 2016). In this sense, knowledge assimilation is highly dependent on the complexity of the knowledge (Batarseh *et al.,* 2017). As the complexity levels increases, more qualified workers are required to ease this assimilation process.

The higher skill levels or years of experience, so related, the higher prior knowledge levels (Buenechea-Elberdin *et al.,* 2017). The active role of the top management can facilitate the knowledge assimilation and integration. Thus, we are interested in when managers are working with human resource practices to achieve the above situations. That is when organizations are improving their levels of training and experience, among others, through the recruitment of highly qualified personnel. Taking into account these deliberations, the subsequent hypothesis can be specified as:

H3: The inputs of superior human capital is significantly and positively associated with the firm's technology management.

For contributing to the research, Figure 1 displays the planned model and we can see the organization's human resources in a technological industry to explicate the firm's technological decisions in a turbulence environment.

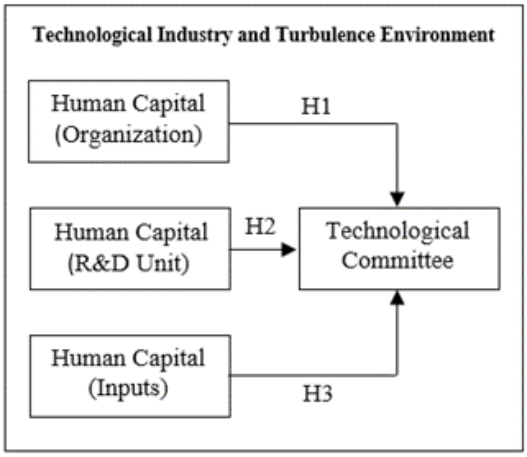

Figure 1. Model of human capital profiles for the firm's strategic technological decisions (source: Own elaboration).

3. Research methodology

3.1. Data and sample

With the goal of contrasting the earlier planned hypotheses, an empirical study was arranged on the basis of the Spanish industrial companies that answered to the Survey of Business Strategies (SBS). The SBS has been realized by the SEPI Foundation in relationship with the Spanish Ministry of Science and Technology and aspires to investigate the strategic progression of Spanish manufacturing firms. This survey shows an unbalanced panel since some entities conclude to provide data while others persist to do so every year. Especially, one of the points that distinguish the SBS from other data sources is its explicit objective of generating information with a panel structure (Sáiz *et al.,* 2018). All the data integrated into the SBS is exposed to corroboration and reliability controls.

To carry out this study, a sample is included of a balanced panel of 5,566 companies. There were counted exclusively those firms that have consistently replied in the exploration period, 2010-2015 to establish a sample of the complete panel of firms. Accordingly, 1,220 organizations for a three-year period was utilized, which signifies a total of 3,660 cases. The turbulence environment accounted for 694 cases and the medium and high technology sectors involved a total of 226 observations. The panel distribution is shown in Table 1. With a confidence level of 95%, the sampling error was 0.245.

Table 1. Panel distribution for Spanish firms in the medium and high technology sectors (2010-2015).

Medium and high technology sectors	Turbulence context	Stable context
Chemical industry	61	204
Agricultural and industrial machines	51	171
Computer, electronic and optical products	14	46
Machinery and electrical apparatus	28	113
Motor vehicles	54	132
Other transport material	18	45
Total	226	731

3.2. Variables

The variables employed insights from prior literature and follow principally Diaz-Diaz and De Saá (2014) and Sáiz *et al.* (2018). This section defines how concepts were determined from the SBS questionnaire.

The dependent variable is the Technological Committee. This measure takes the value 1 if the company replies affirmatively about the existence of a firm's technology committee, and 0 if it does not.

Explanatory variables. The Human Capital is measured by three variables. The first variable includes the superior levels of engineers and graduates in the R&D unit. The following constructs reflect the firm's superior levels of engineers and graduates and the recent incorporation of these qualified workers.

Selection variable: Turbulence Environment, which takes the value of 1 if the firm answers affirmatively to the question about expanding markets, and 0 if it does not.

Control variables. These constructs are: Size calculated as the logarithm of the number of workers. Age, as measured the number of years since the company's founding and the firm's Return on Assets. Location calculated as a dummy variable, which takes the value of 1 if the company responds affirmatively to the question about national or international markets.

3.3. Results

Our dependent variable is dichotomous or binary. For this cause, to test the supposition, a regression binomial logical model examines the relationship between the human capital measure and the firm's technological committee. The planned model was assessed using the econometric package SPSS (Statistical Product and Service Solutions) version 24 for Windows. The researchers select this statistical program for its applicability and ease in handling.

The statistical, expose in Table 2 to Table 5, highlights the suitability and good fit of the regressions completed to estimate the model for the technological industry. First, the Chi-square statistic is significant ($p<0.001$) and denotes that the model achieves a significant increase compared with the null model. Second, the R^2 of Cox and Snell and the R^2 of Nagelkerke, as guidance indicators, inform on the goodness of fit. In this instance, these statistics get high values of 0.449 and 0.599 respectively in Table 3. Third, the model can be differentiated

Table 2. Binomial logical regression of human capital (organization) on the firm's technological committee.

Variables	B (Wald)
(Constant)	-3.079***
	(9.378)
Size	1.449****
	(19.406)
Age	0.009
	(1.621)
ROA	-534.915
	(1.011)
Location	-0.415
	(0.589)
Human capital (Organization)	1.434****
	(19.701)
R^2: Cox and Snell	0.215
R^2: Nagelkerke	0.287
Chi-quadrate	53.925****
-2 logarithm of the likelihood	254.676
N	226
% correct division	72.2%

**** p <0.001; *** p < 0.01; ** p < 0.05;* p < 0.1

Table 3. Binomial logical regression of human capital (R&D unit) on the firm's technological committee.

Variables	B (Wald)
(Constant)	-1.656
	(1.809)
Size	1.604****
	(15.374)
Age	0.010
	(0.958)
ROA	-222.377
	(0.088)
Location	0.300
	(0.203)
Human capital (R&D unit)	3.353****
	(65.157)
R^2: Cox and Snell	0.449
R^2: Nagelkerke	0.599
Chi-quadrate	129.14****
-2 logarithm of the likelihood	171.119
N	226
% correct division	86.6%

**** p < 0.001; *** p < 0.01; ** p < 0.05;* p < 0.1

among the different selection groups. The correct classification percentage of observations is high for the technology committee presence, for example, more than 86% in Table 3.

Concerning control variables, results show that the organization's size has positive and significant effects on the dependent variable. Moreover, the age, ROA and geographical location have no significant effects on the technological committee in the turbulence environment.

With the intention of contrasting hypothesis H1 associated with the first measure of human capital, specifically, the availability of engineers and graduates in the company above the industry average. The results of Table 2 indicate a positive and strong significant influence of the human capital (organization) on firm's technological management ($p<0.001$; Wald, 19.701) in technological industry and turbulence environmental, in order to test H1.

With the intention of testing hypothesis H2 related with the second measure of human capital, in particular, the presence of engineers and graduates in the R&D unit above the industry average. Table 3 reveals a positive and strong significant influence of the human capital (R&D unit) on the dependent variable ($p<0.001$; Wald, 65.157) in technological industry and turbulence context, in order to test H2.

Finally, with the aim of testing hypothesis H3 related to the third measure of human capital, especially, the recent incorporation of engineers and graduates in the organization. The results of Table 4 denote a positive and weak significant effect of the human capital (inputs) on firm's technological management ($p<0.1$; Wald, 3.002) in technological industry and turbulence environment, in order to test H3.

To drive general conclusions, in Table 5, we depict the evolution of the significance of the three human capital profiles together. We can see that the human capital of the R&D unit ($p<0.001$; Wald, 56.489) globally concentred the explication despite the variables entry. Furthermore, when this regression obtains the best results in all statistics examined, such as the highest R^2 of Nagelkerke (0.610) or the minor logarithm of the likelihood (167.854) which, in turn, indicate a better adjustment of the model.

In synthesis, according to the empirical results showed for the observations of our complete panel of Spanish industrial companies, in particular, for the technological industry in the turbulence environment, measures of human capital, such as elements in the assimilation phase of the absorptive capacity, are robustly related to the organizational ability to adopt new strategic decisions (technological committee). And it is resolved that the superior level of the human capital is relevant to understand the firm's strategic

Table 4. Binomial logical regression of human capital (inputs) on the firm's technological committee.

Variables	B (Wald)
(Constant)	-2.351**
	(5.027)
Size	1.059***
	(10.967)
Age	0.009
	(1.490)
ROA	-642.608
	(1.980)
Location	0.252
	(0.235)
Human capital (Inputs)	0.533*
	(3.002)
R^2: Cox and Snell	0.147
R^2: Nagelkerke	0.196
Chi-quadrate	35.442****
-2 logarithm of the likelihood	273.159
N	226
% correct division	63.2%

**** p < 0.001; *** p < 0.01; ** p < 0.05;* p < 0.1

technological decisions. Finally, it is concluded that the most important profile is the human capital of the R&D unit. Second, the firm's human capital and, third, the inputs of new human capital.

The contributions of this work should be noticed as it is founded on panel data models and are coherent with prior studies, associated with the cooperation activities and absorption process (Sáiz *et al.,* 2018), the technology alliance diversity (Lucena and Roper, 2016), the R&D function (Sánchez *et al.,* 2013), the firm's innovation (Segarra-Ciprés *et al.,* 2012), the size of the company (Revilla and Fernández, 2012) and the technological knowledge assets (Díaz-Díaz *et al.,* 2006).

4. Conclusion and limitations

This research exposes relevant empirical consequences that make a principal support to explain the issue about the presence of technological committee in turbulence environments. When the companies have an average above the industry of engineers and graduates, above all, in the R&D unit, assume that they have the adequate level of human resources to organize around the technology committee, and optimize their processes of knowledge assimilation.

Table 5. Binomial logical regression of human capital profiles on the firm's technological committee.

Variables	B (Wald)
(Constant)	-1.876
	(1.797)
Size	1.732****
	(14.452)
Age	0.010
	(1.177)
ROA	-116.315
	(0.019)
Location	0.188
	(0.079)
Human capital (Organization)	0.768*
	(3.261)
Human capital (R&D unit)	3.203****
	(56.489)
Human capital (Inputs)	-0.013
	(0.001)
R^2: Cox and Snell	0.457
R^2: Nagelkerke	0.610
Chi-quadrate	132.41****
-2 logarithm of the likelihood	167.854
N	226
% correct division	84.8%

**** p < 0.001; *** p < 0.01; ** p < 0.05;* p < 0.1

With regard to the use of engineers and graduates, the paper findings confirm that the relationship between superior levels of the human capital and firm's technological committee in technological sectors on turbulence environmental, as stated H1, H2, and H3.

From the knowledge management literature, the absorptive capacity contributes to valuable explications to the technological decisions and arises as one of the issues most relevant to the R&D function. This capacity is determined by the needs of knowledge to be absorbed and can be used to adopt investment decisions in R&D or alliances. In addition, a good knowledge assimilation structure is critical to complete the knowledge absorption. This research finds that those companies that maintain levels in qualified workers (engineers and graduates) higher than the industry average in the R&D unit or in the firm, or newly incorporated, are more likely to deploy the technology committee, which involves an internal capacity to absorb and supports the knowledge absorption process. In other words, in the dynamic and technological contexts, this investigation reveals that firms that assimilate more knowledge are more prepared to manage it.

Concerning limitations, it would be stimulating to expand the work to the relation of firm's technological committee and other questions related with the planning of an innovation strategy and the follow-up of innovation performance, examining the entire construct of firm's technological management. Furthermore, the election of external sources of knowledge represents an essential decision for the company's innovation about the knowledge assimilation process. Future research direction should also aim to investigate the profiles of human capital in the entire process of absorption to the innovation performance. There may be further evidence of the relationship among superior levels of human capital, agreements of cooperation and quantity of innovations, which are not incorporated in this study, and could be interesting to assess in future investigation.

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