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Project Risk Management Implementation in SMEs: A Case Study from Italy

Priscila Ferreira de Araujo Lima¹ and Chiara Verbano^{1*}

Abstract: Despite its strategic importance, the diffusion of Project Risk Management (PRM) is limited mainly to large companies, leaving a lack of empirical evidence addressing small and medium-sized enterprises (SMEs). Therefore, the objective of this paper is to analyse how to adopt PRM in SMEs with a positive cost-benefit ratio, considering risk management (RM) phases, activities, tools, instruments, procedures and organisational aspects that enable the effective implementation of PRM in SMEs. To identify the fundamental dimensions to insert in the framework, a systematic literature review was performed, and a pilot case study was conducted to test the validity of the empirical framework and improve it. Moreover, after the case analysis, the benefits obtained and the difficulties faced through the adoption of PRM are presented and discussed.

Keywords: project risk management; project management; small and medium-sized enterprises; empirical framework; case study

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Introduction

According to ISO 31000:2009, risk is defined as the effect, in terms of positive or negative deviation from the expected outcome, resulting from uncertainty on targeted objectives. Risks can affect organisations in terms of economic performance, business continuity, reputation, environmental and social outcomes; therefore the management of risks supports organisations in reaching their targeted objectives, reducing potential losses and exploring new opportunities in an environment full of uncertainties (ISO 31000, 2009; Radner & Shepp, 1996). Consequently, all types of organisations are taking a greater interest in risk management (RM), recognising the deriving benefits.

The aim of RM is to reduce the potential for risks and mitigate the impact of possible losses (Bajo et al., 2012). RM is a continuous process of defining objectives, identifying sources of uncertainties, measuring probability and severity of the potential consequences and formulating managerial responses to risks and opportunities (Henschel, 2006).

The literature classifies RM into 9 different streams, based on the different approaches used, the risks considered, the techniques applied, the methodologies proposed and the fields of application: Clinical RM, Disaster RM, Engineering RM, Enterprise RM, Financial RM, Insurance RM, Project RM, Strategic RM and Supply Chain RM (Verbano & Venturini, 2011).

Project RM (PRM) is an integral part of Project Management (PM), where PM is the application of methods, knowledge, tools and techniques to a project, integrating the various phases of a project's lifecycle in order to achieve its goal (ISO 21500:2012; PMI, 2017). The PM process is divided into five phases (i.e., initiation, planning, execution, monitoring & control and closure) (ISO 21500:2012), and its main purpose is to increase the organisational value (Dalcher, 2012). Most companies are aware of the importance of a structured approach to

PM (Miklosik, 2015) and of the increased effectiveness and efficiency of human effort in the organisation that is obtained through PM (Fernando et al., 2018), opting then for its adoption.

When a project is implemented in a company, it is essential to design all of the project's lifecycle and identify all the possible sources of risks that can be technical-operational, organisational, financial and strategic (Badri, 2015). To ensure project success in today's competitive environment, an organisation must manage these project risks effectively, even though various difficulties are experienced (Shenhar et al., 2007; Srivannaboon & Milosevic, 2006). Through the identification of such risks, the managers are able to study the possible positive and negative outcomes and define the correct response to treat them in order to assure the success of the entire project. Commonly, in most types of organisations, many efforts of managers are expended on dealing with project risk-related issues (Fernando et al., 2018). PRM activities, tools and techniques and organisational aspects offer an approach to manage these risks proactively in order to improve the projects' probability of success.

PRM contributes to identify the project objectives, improve the project monitoring and control, improve communication among the project stakeholders, facilitate decision-making and increase the chances of project success (PMI, 2013; Raz & Michael, 2001). It is a subset of PM, both in the Project Management Institute (PMI) framework and in the ISO 21500 (ISO 21500:2012; PMI, 2013), composed of four phases: risk identification, risk analysis, risk treatment and risk monitor & control (PMI, 1996).

The aim of PRM is to systematically identify, analyse, treat and monitor & control project-related risks by decreasing the probability and impact of occurrence of negative ones (threats) as well as increasing the probability and impact of occurrence of positive events (opportunities) during the project (Borge, 2002; PMI, 2013).

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Given its importance, in the last years, many companies, from different types of industries, have adopted PRM. Using the appropriate tools, PRM provides an effective means for managing a complex project against time, cost and quality non-achievement (Dey, 2012).

Also, Elkington and Smallman (2000) claim that PRM is essential for the project's success. They have identified that the most successful projects implemented more RM practices. In fact, the earlier RM is initiated, the more successful a project becomes.

RM process activities and the criteria for choosing among risk techniques have been extensively studied and implemented in both literature and practice. However, these criteria usually do not consider either the characteristics of the project and of its surrounding environment or the attitude of an organisation towards risk (Cagliano, Grimaldi, & Rafele, 2015).

Despite its strategical importance, PRM diffusion is limited mainly to large companies, leaving a lack of empirical evidence addressing small and medium-sized enterprises (SMEs) (Kim & Vonortas, 2014). The SMEs vulnerability, because of a combination of resource-related constraints (i.e., human, technical and financial constraints), low bargaining power and sensitiveness to business risk and competition, leads to an additional need of PRM adoption (Blanc-Alquier & Lagasse-Tignol, 2006; Dallago, Guglielmetti, & Rondinelli, 2012).

However, different frameworks of RM are necessary, depending on the size of the project to facilitate the RM application in SMEs (Turner, Ledwith, & Kelly, 2010). According to Marcelino-Sádaba et al. (2014), SMEs need less bureaucratic PM models, with perhaps a different toolset to traditional versions designed for medium or large projects, which could facilitate the RM throughout the project lifecycle.

With the aim to investigate the diffusion of PRM among small companies, a bibliographic search was conducted in the two most widespread academic databases, Scopus and Web of Science, using different combinations of the following keywords: 'risk management', 'SMEs' and 'small business'. After a careful selection process, in which the proceeding papers, editorial materials, non-English language papers, non-pertinent

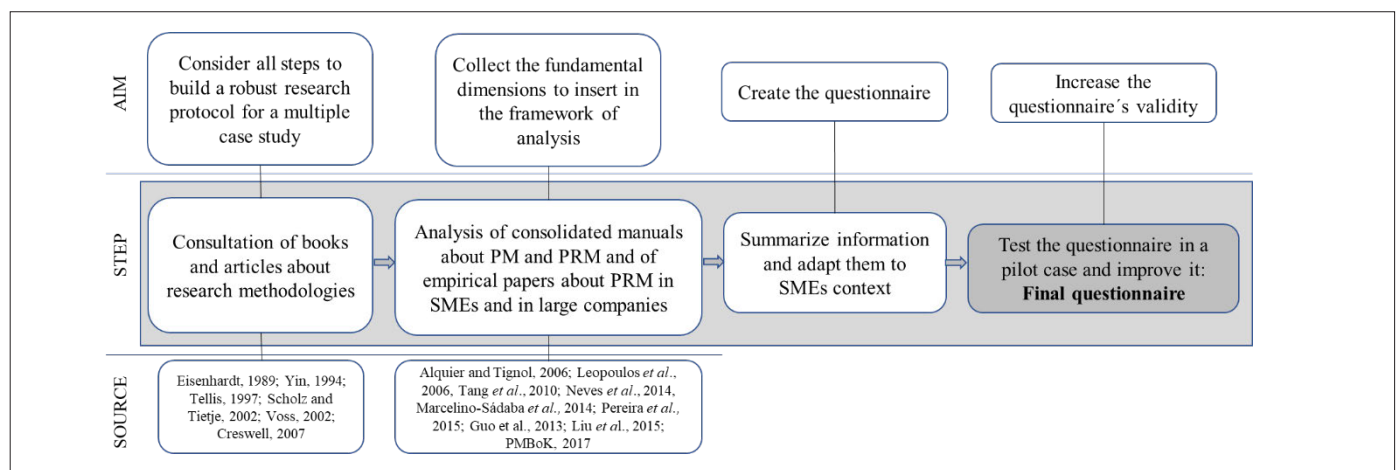
articles were excluded, only six papers about PRM in SMEs were found. All six papers were empirical studies (i.e., three case studies and three model proposal and testing). Three of the studies were applied in the industrial sector, two were applied in the service sector and one was applied in both sectors. Only half of the papers contemplated all project risk types and, as for the PRM phases, only in two of them all phases were applied. Despite its overmentioned importance, PRM is neither much studied nor widespread in SMEs (Marcelino-Sádaba et al., 2014), and, given the abovementioned results, it was possible to conclude that there is a significant gap to be fulfilled with new researches.

Objectives and Methodology

The objective of this paper is to analyse how to adopt PRM in SMEs with a positive cost-benefit ratio, considering RM phases, activities, tools, instruments, procedures and other organisational aspects that enable the effective implementation of PRM in SMEs. Given the nature of the objective of this research, an exploratory and explanatory research through the case study methodology has been chosen, as it is the most appropriate one for this type of study (Yin, 1994). To this extent, an empirical framework of analysis has been specifically developed to conduct a multiple case study focused on projects in SMEs, in which PRM was adopted with a positive cost-benefit ratio. In this paper, a pilot case study will be presented, aiming specifically at testing the validity of the empirical framework and improving it; moreover, first indications to promote PRM adoption in SMEs will be grasped from the analysis of the pilot case.

To build the research protocol, firstly, well-known books and significant articles about research methodologies were consulted. After that, consolidated manuals about PM and PRM, as well as empirical papers about the adoption of PRM by different types of companies, were analysed in order to collect the fundamental dimensions to be inserted in the theoretical framework. All the collected information was adapted to the SMEs context and summarised to support the questionnaire creation. The steps of the methodology and their specific aims are presented in Figure 1.

Figure 1: Construction of the research protocol



The resulting questionnaire is divided into eight sections: (1) Company profile and respondents; (2) Project overview (i.e., the main characteristics, objectives and specific items useful to understand the innovativeness and the complexity of the project); (3) PRM process and organisation (i.e., the phases and roles involved); (4) PRM identification phase; (5) PRM analysis phase; (6) PRM treatment phase; (7) PRM monitor & control phase. (8) Outcomes of the PRM adoption (i.e., the benefits, time and costs of implementation, as well as the enabling factors and obstacles). In each of these sections, the activities performed, the tools and techniques used, the results obtained and the main difficulties encountered were also questioned.

The pilot project was selected based on the adoption of PRM by a SME, the type of industry in which it was implemented (i.e., ICT services) and the availability and knowledge of the project manager and other members of the project team. Furthermore, to ensure the project's internal validity through triangulation and to increase data reliability (Voss, Tsikriktsis, & Frohlich, 2002), the results of the in-depth interviews with multiple respondents were integrated with the analysis of documents related to the PRM plan and outcomes, which were delivered to the researchers.

Results

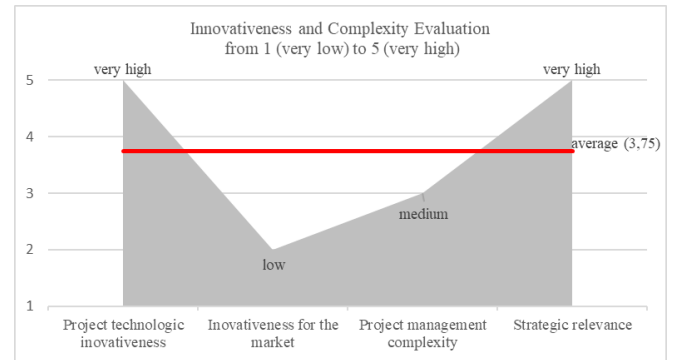
Company profile and project overview

For this pilot case study, a small-sized consultancy company – organised by projects – was selected. The company employs 48 people and has a turnover of five million Euros. Moreover, its main activity is the development of Customer Relationship Management (CRM) systems that focus on user adoption (i.e., the spontaneous and profitable utilisation of CRM by its users). To protect the company's confidentiality, moving forward, the company will be referred to as 'Alpha'.

The analysed project consisted of implementing a new CRM system to an external client that belonged to the automotive industry and had the ambitious objective of increasing its annual income by 30%. The project cost 60,000 Euros and involved seven people for seven months. Two members of the project team were interviewed: firstly, by the project manager and, secondly, by the manager's assistant, who played an important role in verifying and integrating the previously collected data.

In order to understand the main characteristics of the project, the interviewees were asked to classify the project's innovativeness and complexity on a Likert-type scale, from 1 (very low) to 5 (very high). The technological innovativeness was considered to be very high, while the client's market innovativeness was considered to be low. The complexity of the PM was rated as 'medium', while the project's relevance for the company's strategy was considered very high since both the project manager and the assistant believed that having success in this project may allow the organisation to enter into a new market. The average score obtained from the project's innovativeness and complexity is 3.75 (as displayed in Figure 2), highlighting a potential medium-high level of risk that is usually associated with the abovementioned characteristics.

Figure 2: Project's innovativeness and complexity evaluation



PRM process and organisation

The project manager was responsible for the PRM. The assistant helped the project manager throughout the process, and the sales manager was involved during the identification, the analysis and the monitor & control phases. Table 1 displays the general information about the PRM process and the organisation adopted in the project.

Table 1: PRM overview in the analysed case

PRM overview	
Implemented PRM phases	identification, analysis, treatment, monitor & control
PM phases with PRM adoption	initiation, planning, execution, closure
Responsible for PRM	project manager (supported by his assistant)
PRM team	project manager (PRM responsible) project manager assistant sales manager
Risk owners identified	yes

Risk identification and analysis

In this project, as in all other projects of Alpha, a preliminary analysis was performed. The analysis consisted of a three-day evaluation, with the aim of defining the actual picture of the company's infrastructure and understanding the possible interactions between the client's information system and the CRM system to be implemented. Thus, the outcomes of this analysis served as an input for the project planning.

During this preliminary analysis, the activities to be performed were ordered by importance in a matrix (deriving from a cost-benefit analysis), and the possible risks that may be faced during the project were identified and analysed. Therefore, the first two phases of the PRM process, risk identification and risk analysis, were proactively performed in this first PM phase (i.e., initiation).

In particular, for the risk identification, the activities performed – mainly to check the feasibility – were context analysis, stakeholder analysis and risks and opportunities identification, while the main tools used were brainstorming, interviews with experts, SWOT Analysis and the 5 Whys technique. No relevant, technical-operational

risks were identified; however, if there were any identified in this preliminary analysis, the company would not have accepted the project. In addition to that, as a mitigating action, a clause in the contract signed by the client allows Alpha to interrupt the project if any risks related to the IT structure emerges.

Strategic risks, however, were identified (e.g., the possible issues impeding an effective user adoption), in addition to few organisational risks (i.e., the operational risks); for example, there was a risk of assigning part of the project to an inexperienced or low-skilled software engineer, which, in turn, opens the risk of not delivering the project in time. The client was considered to be reliable from a financial point of view; thus, no relevant financial risks were considered.

Besides the risks, an opportunity was also identified: to turn this project into a model for future clients in the automotive industry. For this reason, the project manager devoted all his effort towards obtaining a specific CRM model for this industry by the end of the project.

The main obstacle encountered in this phase was understanding what the main risks for the client were. The project manager and the assistant, who were responsible for the PRM, were very concerned about the risk of not satisfying the client because of the potential difficulties that could be faced during the CRM user adoption. Such difficulties could not only jeopardise the project but also threaten the opportunities of making the project a successful case and attracting new clients in the market.

During the risk analysis, the project team focused on analysing the consequences of the risks identified as well as the risks that could arise during the execution of the project. The tools and techniques adopted in this phase were the 5 Whys technique and a cost-benefit analysis, obtaining a qualitative evaluation of the identified risks. No risk prioritisation was done in the project. The risk related to the user adoption and the eventual lack of skills of a team member were analysed. For example, the user adoption was considered a risk with a significant negative impact for the company's strategy in case it occurred, while the lack of knowledge of one of the software engineers could incur into extra working days, which means a loss of money.

Despite all the analysis conducted, they did not create a risk register and, because of a CEO's decision, the risks were not reported in any document. Several difficulties were faced during the risk analysis, and the main ones were the possible unreliable information given by the client and the need to deal with unexpected risk. Given the activities and connected risks, the project manager approved the preliminary analysis and officially started the project. During the project lifecycle, the project manager had the responsibility of having these initially identified risks under control.

Risk treatment

The definition of risk acceptance threshold was based on the consultants' feelings and knowledge, without any type of objective or quantitative analysis threshold.

Firstly, risk treatment was performed in the preliminary analysis. With the aim to assure project success, every source of technical

impediments related to the client infrastructure was accurately considered and, if detected, the project would have been excluded to avoid the risks. Moreover, to transfer other potential technical risks emerging during the project, a clause in the contract allows Alpha to interrupt the project if any risk related to the IT structure, and not initially individuated, emerges.

Two specific techniques were used to complete the risk treatment during the project implementation: risk mitigation and, more widely, risk transfer. Both the project manager and the assistant recognised that these actions should be planned in advance; nevertheless, as in most of the company's projects, they managed both the risk mitigation and the risk transfer 'live' (i.e., following a reactive approach). For example, in this project, an SMS alert system was implemented in the CRM with a particular template and a timer. While this SMS system was being built, one of the client's managers was replaced by another one, who was not satisfied with the final template nor with the timer configuration and asked for modifications. These changes imply extra working hours for Alpha's engineers; therefore, Alpha transferred the risk of extra costs to the user since the specifications of the user requirements were different from what was specified in the contract. As a result, the sales manager created a change request, and the client paid for it.

Another risk that occurred in the project was related to the lack of skills of one of the software engineers. During the second day of the project, a software engineer – as a member of the project team – asked the project manager to leave the project because he was not capable of developing all of the required activities. Since this was an expected risk, the project manager had already considered another person and made a substitution in the project team; however, this replacement could not be done immediately so, in the end, two working-days were lost (i.e., approximately 1,500 Euros). In this case the risk was partially mitigated but not completely avoided.

A significant difficulty faced in this phase was to involve the client, given his poor availability.

Risk monitoring & control

During this phase, the main two activities carried on were change request monitoring and risk trigger monitoring. To this extent, a risk tracking tool, called 'GIRA', was developed by the software engineers of Alpha using an Agile logic. Through 'GIRA', the project team was able to keep track of any change request and the eventual problems that emerged during the project execution. This tool was also useful to support the project manager to discuss with the client and decide which treatment action to take when needed. The main difficulties faced during this phase were the lack of time, the need of dealing with non-calculated risks and the lack of information provided by the client.

Once the project finished, a meeting involving all the project members was held at Alpha, during which they discussed and reported the lessons learned about how to avoid in the future the same difficulties and problems encountered in this project; these results were not documented.

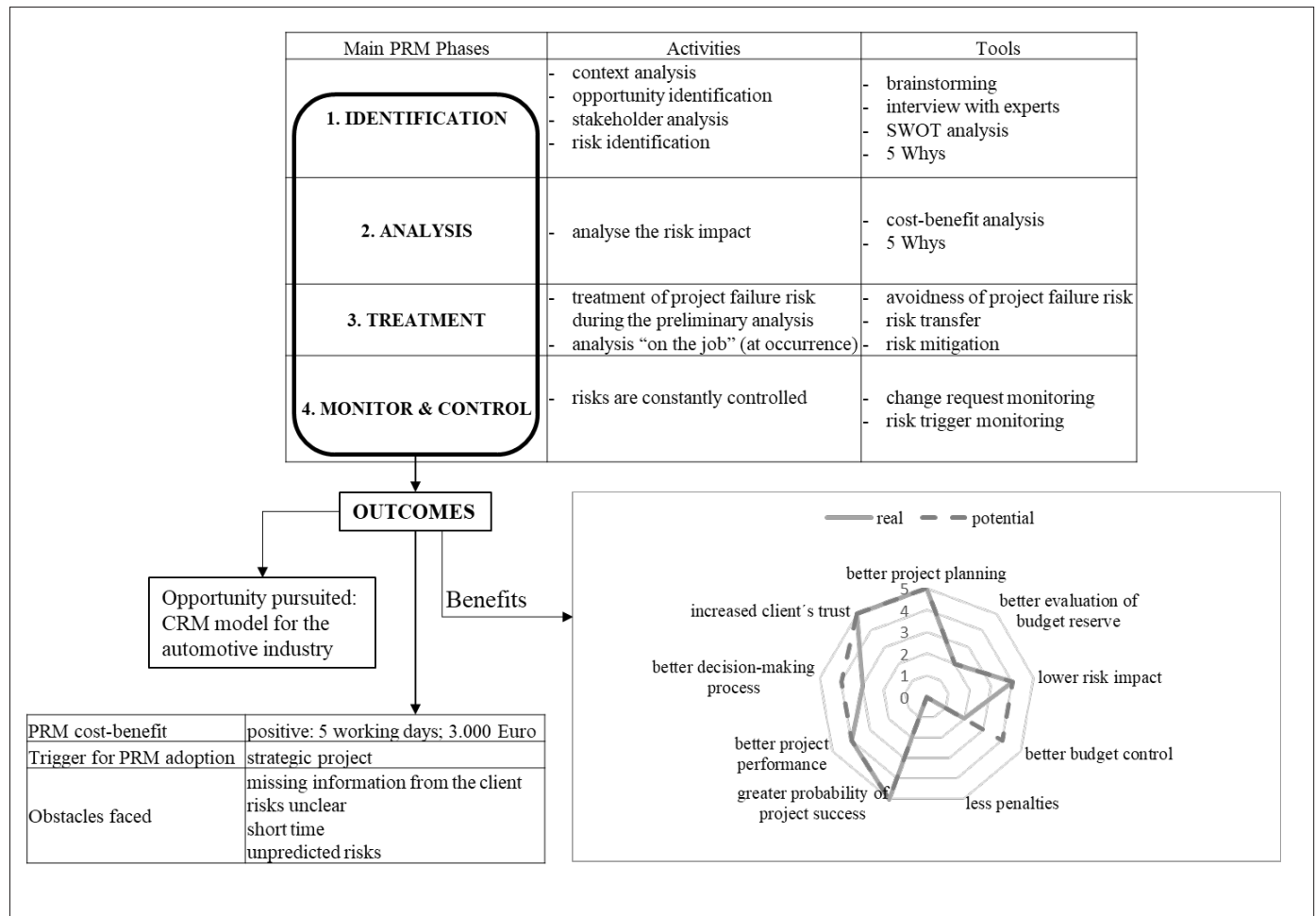
PRM Outcomes

According to the consultants, the use of PRM in this project had a very high impact on improving the project planning, increasing the probability of project success and increasing the client's trust. Moreover, the project manager and the assistant also affirmed that PRM has highly contributed in reducing the risk impact and improving the project's performance. Through PRM application, the main risks were avoided, and a significant strategic opportunity was identified; thus, pursuing this opportunity gave extra motivation for the project team. Besides that, both interviewees affirmed that PRM supported them in the decision-making process, but it was not very significant because there was no risk register, and risk evaluation was not performed in a systematic way. However, the project manager believes that, if the PRM process were more structured and the risk analysis were deeper, the project team would have more reliable information about the project that could considerably contribute in the decision-making process; therefore, potential PRM outcomes are even higher than the actual outcomes.

The adoption of PRM had a low impact on improving the evaluation of the budget reserve and on the budget controlling, since there was not a quantitative risk evaluation; however, both respondents believed that these outcomes could benefit from an improved application of PRM.

The project manager and the assistant believed the PRM benefits obtained overcame the implementation costs (i.e., approximately 3,000 Euros) and the time spent in its analysis (i.e., 5 working days). They also believed that it should be implemented in all types of projects. They further pointed out that the strategic nature of the project gave a strong motivation for the PRM adoption. Among the main obstacles faced during the PRM implementation were: risks not clearly identified at the beginning of the project, difficult communications with the client and time constraints. Nevertheless, the opportunity identified in the preliminary analysis was successfully achieved; thus, by the time of the project's closure, Alpha developed the main structure of a specific CRM model for the automotive industry. Figure 3 summarises the results obtained from the pilot case, according to the framework of analysis.

Figure 3: PRM process and outcomes



Discussion

The project analysed was successfully completed. From the analysis of the PRM, it was possible to grasp interesting evidence about how to adopt PRM in a SME. Firstly, besides all the qualitative benefits obtained from the PRM, it is important to highlight the positive cost-benefit ratio between the RM outcomes and implementation costs, which can motivate the development of RM also in this type of company. Likewise, the study of Fernando et al. (2017) confirmed that PRM is positively related to PM performance.

In more details, Alpha devoted most of its efforts (i.e., in time and depth of the analysis) in identifying and dealing with the risks of project failure during the very early initiation phase of the project, in order to accept it only if project success is likely attended. This is realised in the preliminary analysis with a proactive approach, revealing the company knowledge and awareness that risks may lead to a complete project failure. Moreover, the project's success gave the company the important opportunity of captivating clients in a new market, which was identified and pursued because of the PRM. This result reinforced the affirmation of Carvalho and Rabechini (2015), who stated that PRM can use a mapping method of the threats and opportunities to develop new models.

This preliminary analysis also disclosed a positive characteristic of Alpha: a strategic vision. According to Carvalho and Rabechini (2015), PM needs to be embedded in strategic thinking on project risks to ensure the completion of the PM activities. The entire project team was involved in the PRM, which was also a positive result since, according to Radnor and Walley (2008), the entire staff should be involved and consulted in order to increase motivation and create conditions for a sustainable implementation.

The analysis also revealed that the main difficulties faced in Alpha's PRM process were the need of managing risks on the job, the unreliable information given by the client and the attempt to involve the client in the PRM process. Among the weak points, the following were highlighted: the lack of a risk register, the unstructured risk acceptance threshold definition (based on the consultants' feelings and experiences), the unwillingness of the top management to invest more time on PRM, the uncalculated cost of risk response and the absence of a document registering the lessons learned. Therefore, many decisions were purely based on the consultants' knowledge and experiences. When analysing the outcomes of the PRM adoption, the consultants presume that an improvement in the PRM process would significantly affect the benefits obtained.

In relation to the academic implications, the empirical framework developed for SMEs and tested in the pilot case allows researchers to analyse the PRM main dimensions and to determine the cost-benefit ratio connected with its adoption. After the pilot case, the questionnaire was improved: through its application it was possible to correct incomplete or unclear information and to complete the data collection requiring specific examples for every PM phase emerged. The resulting framework can give a valuable contribution to the literature

since, to our best knowledge, this type of framework was not present. Regarding the practical implications, the Alpha case gives an example of an effective and efficient RM in the preliminary phase of project initiating, assuring project success; meanwhile, suggestions to improve the PRM have been highlighted, in order to improve project performance and fully benefit from the PRM adoption. Finally, this study confirmed that PRM adoption in SMEs is still at early stages, as emerged from the literature (Kim & Vonortas, 2014).

Conclusion

Although this is a pilot case, limited to a specific industrial sector, it provided first indications about the PRM adoption in SMEs. The strategic vision of Alpha is one of their main strengths. The company concentrates its efforts in managing the risks of project failure to ensure the success of its projects, which is the main fundamental goal to be pursued through a PRM system, followed by optimising performance and extending a proactive approach to manage the other project risks that, if not carefully managed, often cause an increase in project costs and completion time.

As it emerged in the literature review, one of the reasons for SMEs to not apply PRM is that CEOs may believe its costs are not justifiable. However, the positive cost-benefit ratio obtained in this project shows that the benefits obtained from the PRM adoption overcome the related costs.

This pilot case verified the validity of and refined the proposed empirical framework. It could be used in future studies, which should focus on different types of industries, specifically considering the size of the company (i.e., small or medium) and the company's production organisation (i.e., whether the company is organised by process or by projects), besides the previously mentioned characteristics.

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A Hub-based University Innovation Model

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Abstract: This article uses a conceptual approach to propose an innovation model for regional universities. It demonstrates that the traditional university encounters several obstacles that hinder its full integration into the development of its respective region and explains why currently known models cannot adapt to regions that have deficient relationships with the government and lack an entrepreneurial base. The new model is based on a structure composed of units called “innovation hubs” and incorporates social innovation, thus permitting the university to become integrated into the regional innovation ecosystems. The Magdalena University in Colombia was used as a reference in developing the model.

Keywords: hub; social innovation; university innovation models; regional innovation ecosystems

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Introduction

Changes in demographics, society, and especially technology, which have been expressed through external demands, (Martin-Sardesai, Irvine, Tooley, & Guthrie, 2017) require universities to reflect upon their need for transformation (Youtie & Shapira, 2008) from the former model wherein they are seen as isolated producers of knowledge (Novoa, 2016) to an integrated one wherein they are understood to be part of a regional innovation ecosystem (Dedehayir, Ortt, & Seppänen, 2017). General models such as the triple helix model propose the integration of the three main agents—business, government, and university—in the creation of regional innovation ecosystems (Sarpong, AbdRazak, Alexander, & Meissner, 2017; Molina, Polanco, & Montes, 2015). Other models based on this one have been proposed and adjusted to the specific characteristics of the Ibero-American region (Salazar, 2015); unfortunately, however, these models do not take into account difficulties involving the practicability of their implementation in regional universities located in settings that lack an entrepreneurial base and have insufficient relationships with the government. However, these regions do possess cultural, historical, touristic, and environmental resources that may potentially be exploited in order to allow universities to overcome the economic obstacles in the region and promote a partnership between the public and private sectors based on social innovation. (Rao-Nicholson, Vorley, & Khan, 2017). One example of how social innovation may help promote the potential of a region is the “Saco Crea Project carried out by the government of Colombia in the municipality of Juan de Acosta, more specifically, in the township of San José de Saco, in the Department of de Atlantic (northern Colombia). Based on the knowledge and textile abilities of the inhabitants of the township, the government implemented the MUSA Association initiative in which 20 women from the community produce household items for several home interior stores in the city of Barranquilla” (Villa & Melo, 2015, p.11); unfortunately, initiatives such as this one are scarce and sporadic.

This example highlights the necessity for the development of an innovative model for the regional university. This new model must envision the university as a “builder” of a relationship of trust with the local government and foster the creation of an entrepreneurial base by means of an active participation of the university community that takes advantage of the social potential of the region and allows both national and international agents to encounter adequate conditions for their integration into the region. This model should have a “bottom-up” focus, that is, the individuals from the region, with support from the university, are the ones who generate innovations that allow various actors to be summoned to the elaboration of high-impact solutions that consolidate confidence in the local governments or plant seeds for the construction of an entrepreneurial base.

The novelty of this model must not be derived from merely theoretical approaches, but instead must be based upon the practical experiences of technological and social innovation units that are currently in operation and have become very popular on the international scene. However, the model must be complemented by theoretical principles so that it may be used as a reference for regional universities.

This conceptual study proposes an innovative model for the regional university that is based on the concepts of social innovation, fractal organization theory, systems, networks, and technological and social innovation hubs.

This model developed in this work is based on a case study of the University of Magdalena, due to both its ongoing efforts to become an innovative university and its regional nature, being located in a region that has a sparse entrepreneurial base and lacks sufficient aid from government organizations with regard to innovation.

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Theoretical Background

Social Innovation

“Social innovation is defined as the implementation of programs and initiatives that possess characteristics related to providing a solution to a social, environmental, or cultural problem in a way that is novel and more effective, efficient, sustainable, or just than those already in existence; this solution may take the form of a product, process, technology, regulation, intervention, or social movement, may come from any sector of society (public, private, academic, community, citizen) that seeks a greater benefit for society than for the entity that developed or financed the solution, and is developed and implemented by means of horizontal relationships between the entity that provides the solution and the community that receives it.” (Villa, & Melo, 2015, p.4).

Systems Theory and Innovation Networks

The authors (Carayannis, Campbell, & Rehman, 2016) demonstrate a theoretical relationship between systems theory and innovation networks. The elements of systems theory may be identified with the nodes in an innovation network, and the relationship that forms between innovation nodes is similar to the relationships that form between the elements of a system. The incorporation or elimination of nodes within an innovation network, or a change in the relationship between two or more nodes, may be assimilated to a development in time, which is an important characteristic of systems theory (Forrester, 1995; Abatecola, 2014).

Innovation Hub

Three (3) types of definitions exist for the concept of an innovation hub. The first is associated with regional innovation hubs (Florida, 1995) and is related to the integration of local and external allies who are interested in the development of the region, including the university, NGOs, businesses, and government; another definition of the concept is related to the understanding of the university as an innovation hub that integrates other agents under its leadership into the activities it carries out (Youtie & Shapira, 2008); a final definition of innovation hub is that of a small physical location with meeting spaces, technological support, and specific characteristics that promote social innovation (Toivonen & Friederici, 2015), technological entrepreneurship (InfoDev, 2014), business innovation (Bell, Fletcher, Greenhill, Griffiths, & McLean, 2014; Wire, York, & York, 2016) or the development of prototypes (Gascó, 2017).

Technology Hubs and/or Social Innovation

A specific type of small-scale, specialized, technology-based hub has appeared in Africa and a few other regions in the world during the last several years and has demonstrated great potential for entrepreneurship and innovation (Littlewood & Kiyumbu, 2017). This type of hub meets the need for spaces that may serve as locations for meeting, community development, and the creation of new commercial products (GIZ, 2013).

An innovation hub consists of a small physical space with a wireless internet connection that is furnished with desks, chairs, conference

tables, and portable computers. This space is used for presentations, events, follow-up sessions, and small creative competitions (Toivonen & Friederici, 2015) such as hackathons (Pogačar & Žižek, 2016). “The first organization having these characteristics that define technology and/or social innovation hub was the London Hub, founded in 2005. Another type of Hub exhibiting these characteristics has developed in Africa—the Nairobi iHub, founded in 2010, an organization that has most extensively used the term “Hub.” The London Hub has been emulated around the world, pioneering the creation of a network of such organization, whereas iHub has been used as a model by independent African organizations” (Friederici, 2016).

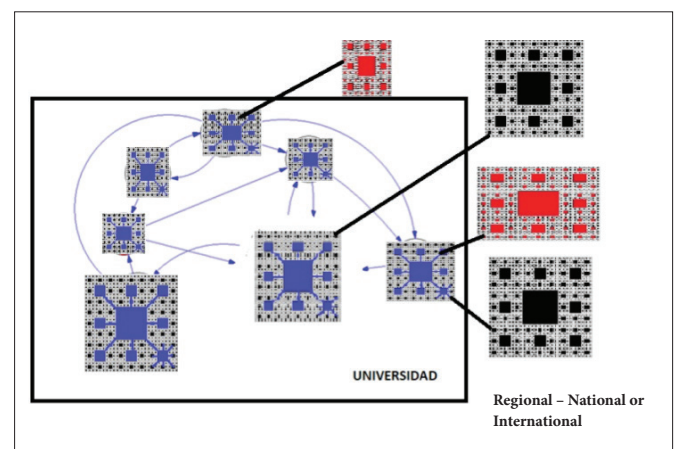
Other versions of technological or innovation hubs exist, such as those created by technology companies or in partnership with governments and international organizations (infoDev, 2014) or else those that use different terminology, such as the Living Labs (Gascó, 2017). In addition, some private businesses such as Red Hat use them to promote their business model (Wire et al., 2016).

Illustration

Proposal for Hub-based University Innovation Model

This conceptual study is based on the theoretical approaches of systems, fractal knowledge networks (Carayannis et al., 2016), open innovation (Johannsson et al., 2015), regional innovation ecosystems, triple helix models, and quadruple helix models (Carayannis & Campbell, 2009; Sarpong et al., 2015). The model will be made up of various subsystems that interact among themselves. These subsystems are formed by a specialized network of technological or social innovation hubs (See Figure 1). Thus, a subsystem may contain fractal-type characteristics (Carayannis & Campbell, 2009) and be made up of other subsystems. The fractal shown in Figure 1 is called the “Sierpinski carpet” (Moreno-Marín, 2002, p.97). The subsystems agglutinate various topics of interest for the university community, whether they are put forward by the university itself or by external agents such as the government, businesses, NGOs, or any other regional, national, or international agencies.

Figure 1. The University is Seen as a Hub Network System with Fractal Characteristics



The Hubs facilitate communication among businesses, governments, communities, funders, and other external agents as well as among internal agents, such as professors, students, and administrative staff of the university, thus allowing for the joint creation of knowledge in the form of open innovation (Johansson et al., 2015). As may be seen in Figure 1, each hub may connect with internal and external agents in an autonomous and/or cooperative manner, and with other Hubs. This characteristic flexibility of these innovation hubs allows them to participate in various systems of external innovation networks, incorporating agents that are outside the university.

The type of Hub considered in this work possesses characteristics that are most similar to those of a technological and/or social innovation hub (Friederici, 2016), and it will be referred to as a MicroRegionalHub.

The MicroRegionalHub for innovation will be defined as a unit that agglutinates knowledge concerning a social problem found in the region (Hunger, Limited access to water, Transportation, Flooding, Inclusion, etc.) for which a solution may be sought through diverse interdisciplinary projects that involve students, professors, or university administrative staff, but which also allow for simultaneous participation by external agents that are interested in the topic. A MicroRegionalHub such as the one being proposed must be created (or activated) easily by the interest of an agent (whether from within or without the institution) and shut down (or deactivated) without too much trouble when interest in the topic has waned or when it becomes necessary to incorporate it into another hub. It should be noted that this type of innovation hub is flexible, allowing it to evolve and adapt to changing environments and to the presence or absence of interest on the part of agents both within and outside the university. Another advantage that this model brings to the university is its capacity to agglutinate knowledge and make it available for use by agents both internal and external to the institution, providing a purpose and interdisciplinary quality to the university. According to this conceptual model, the characteristics of a MicroRegionalHub will now be defined.

Characteristics of a MicroRegionalHub

A MicroRegionalHub must take into account the following three (3) characteristics: Structure, Operation, and Connections. See table 1

Table 1. Characteristics of a MicroRegionalHub

Characteristics	Parts	
Structure	Design	
	Platforms	Administrative
		Virtual laboratories
		MOOC
Operation	Prototypes	
	Methodologies	Café
		Agile
		Hackathon
		Gamification
		Crowdsourcing
Connections	Internal	
	External	

The concept of “structure” includes two components—design and platforms. A MicroRegionalHub must have a design that is similar to that used by the technology and social innovation hubs described above, that is, it must be small and comfortable and must be decorated in a way that encourages motivation, communication, and focus on the topic to be dealt with. Its location must be taken into account in order to be compatible with the culture of its surroundings. To the extent that is possible, the hubs must be capable of being installed, moved, or dismantled quickly and easily. The second component of the structure is that which has been called “platforms.” Each hub must have, as a minimum technological support (or platform), a wireless high-speed internet connection. In addition to this basic technology, other forms of technology are required that allow for coordination of the group of people who work at the hub and increase their productivity. One example of such technologies is Trello (<https://trello.com/>), which makes use of agile teamwork methodologies. Examples of other forms of technologies or platforms such as virtual or remote laboratories (Sánchez, Gómez-Estern, & Muñoz De la Peña, 2012) are very useful in allowing the hubs to maintain communication. Finally, in areas pertaining to technological or platform support, the MicroRegionalHubs must possess technology that is geared toward structuring the information they generate, an example being that of massive open online courses, known as MOOC (Baturay, 2015), which make possible the compilation, dissemination, and appropriation of knowledge by Hub participants.

Another characteristic of the MicroRegionalHub must also be taken into account, namely, the manner in which they are to operate and the manner in which their tasks are to be carried out. The functioning or operation of the MicroRegionalHubs must be grounded in both the development of prototypes (Deininger, Daly, Sienko, & Lee, 2017) and in work methodologies that incorporate open innovation. The MicroRegionalHubs must provide an atmosphere of camaraderie and gamification that allows for the generation of collective ideas, in addition to taking into account the generation of prototypes and the procurement of resources for this purpose.

Six (6) methodologies have been selected for use in a MicroRegionalHub, all of which are currently in frequent use; two (2) of these allow for the generation of innovative ideas in a collective manner (café (<http://www.theworldcafe.com/>) and crowdsourcing (Johansson et al., 2015)), two (2) others allow for the rapid generation of prototypes (agile (Campanelli & Parreiras, 2015) and hackathon), a further methodology is based on the principle of gaming (gamification (Morschheuser, Hamari, Koivisto, & Maedche, 2017)), and the final methodology aids the financing of prototypes (“crowdfunding” (Morschheuser et al., 2017, p.27)).

The third characteristic of a MicroRegionalHub is related to the manner in which it makes both external and internal connections. Although these connections are based on technological characteristics, as in the case of remote laboratories they are related to topics associated with the methods or mechanisms used for the physical exchange of persons and take into account other factors, such as legal, cultural, and economic factors. This third characteristic is foundational for implementing

flexibility and open innovation in a hub, since the desire to move and participate in another hub must be fostered among hub members, therefore requiring a manner in which this may be accomplished quickly and easily. This characteristic must ensure that the hub members can be mobile and promote participation of foreigners in order to create a culture of exchange in the MicroRegionalHub.

Innovation Initiatives of the University of Magdalena About the University of Magdalena

“The University of Magdalena is a state institution of a territorial nature, created by Law No. 005 from October 27 1958, organized as an autonomous institution under special circumstances, related to the Ministry of National Education with relation to policy and planning within the educational sector. It possesses a legal personality, which was conferred by Resolution 831 of the Departmental Government of Magdalena on December 3, 1974. Its purpose is to provide the public service of higher education by exercising its academic, administrative, financial, and budgetary autonomy, with its own independent government, income, and patrimony. It is governed by the Political Constitution according to Law 30 from 1992, as well as the remaining applicable legal provisions in accordance with its special circumstances and the norms that are dictated in the exercise of its autonomy.” (<http://www.unimagdalena.edu.co/Institucional/Paginas/Historia.aspx>). The university is located in the city of Santa Marta, Department of Magdalena, Colombia.

The university currently has an administrative plan for the period 2016–2020 whose goal is to become the most inclusive and innovative university, expressed according to the following governing principles: “Our proposal is based on a diagnostic plan formulated by professors and students in a participative manner, the examination of successful cases of university management, and the foundations of the enterprising or third-generation university (3GU). The proposal is structured according to two complementary perspectives: the mission axes of teaching, research, extension, and their supporting processes, and a group of policies that are geared toward institutional development. The principles for developing this university model are as follows: leadership, orientation toward innovation, academic rigor, social and environmental responsibility, a high sense of relevance, shared governability, transparency, and results-oriented management.” (<http://www.unimagdalena.edu.co/Institucional/Paginas/PlanGobierno2016-2020.aspx>)

The transition toward a third-generation university (3GU) model requires strategic planning and adequate change management. The 3GU model implies new forms of teaching, organization, and financing (Wissema, 2009). The innovation model based on hub may contribute significantly to all characteristics of the 3GU model, but it is especially useful in forwarding the organizational transformation.

The University of Magdalena is currently organized into six (6) schools—engineering, health, humanities, education, business, and basic science; by the year 2020 it should have already made progress in the transformation toward centers and institutes that strengthen interdisciplinarity and transdisciplinarity, which in turn should boost the activities of research,

entrepreneurship, and innovation. (<http://www.unimagdalena.edu.co/Institucional/Paginas/Estructura-Organizacional.aspx>)

Various initiatives and innovation activities have begun to take place in the university in order to fulfill its management plans, such as the adoption of agile work methodologies, the design of spaces for innovation, and the use of software to aid in the administration of the tasks that the university work groups must carry out. Table 2 summarizes these initiatives according to the framework of the proposed model.

Table 2. Some of the activities carried out by the University of Magdalena, examined according to the proposed model

			Activities Carried out
Structure	Design		X
	Platforms	Administrative	X
		Virtual laboratories	
		MOOC	
Operation	Prototypes		
	Methodologies	Café	X
		Ágile	X
		Hackathon	
		Gamification	
		Crowdsourcing	
Connection		Crowdfunding	X
	Internal		
	External		

During the year 2017, the university planning office led the innovation initiatives, using as a reference the proposed model, which has served as an aid in its carrying out the current management plan.

Method

For this conceptual study, an initial literature review of innovation models was conducted. The question that guided the search was as follows: What is an adequate innovation model for a regional university such as the University of Magdalena? The Google Scholar search engine was used to conduct this search, and as a result, deliver the doctoral thesis “Innovation hubs in Africa: Assemblers of technology entrepreneurs” (Friederici, 2016). This thesis was relevant to the goal of this study and therefore was used as the main reference. Based on the information from this doctoral thesis and using the search question as a reference, a second review of the literature was conducted in the Scopus database using keywords such as open innovation, systems, fractal, knowledge networks, hub, social innovation, university, regional development, innovation ecosystems, and models. The resulting documents were then ranked according to the number of citations, and a filter was applied for those that were most cited. Another filter was applied by reading the article abstracts and choosing those that were relevant to the initial search question, after which the articles published in the

journals of highest impact were identified using the scimago platform (<http://www.scimagojr.com/>). This information was complemented with other searches for documents, websites, and doctoral theses.

Discussion and Conclusions

The objective of the conceptual study was to develop an initial proposal for a regional innovation model for the University of Magdalena, based on small technological and social innovation units known as hubs, which are already in operation in various parts of the world, especially in Africa. The model consists of hub networks that allow for open innovation to be promoted by the university, which due to its fractal characteristics possesses greater flexibility that allows it to adapt to changes in the environment and more easily become integrated into the regional innovation ecosystem.

This model is envisioned as an alternative to university innovation models that are based on the overall perspective of business, government, and university, which hinders their implementation in areas having weak relations with the government and a scarce entrepreneurial base. This new model facilitates the utilization of the available social potential of these regions.

The characteristics of an innovation hub that are suitable for a regional university innovation model are described and referred to as a MicroRegionalHub, and it is shown how the innovation initiative currently being carried out by the University of Magdalena might be understood according to this framework.

Future Research

This conceptual study will serve as an initial reference for the research project being conducted by the primary author in order to develop a system model for innovation in regional universities. The short-term suggestion is to conduct case studies in regional universities that may serve as input for the elaboration of a general innovation model that they may implement. The medium-term plan is to verify progress in the innovation models of regional universities that use the elaborated theoretical model as a reference. Further research that may be carried out includes measuring the impact that the university's mission tasks may have on this type of innovation model.

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Facing the Dark Side: How Leadership Destroys Organisational Innovation

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Abstract: Leadership is an essential element for promoting innovation. The literature has primarily focused on the effect of “constructive” leadership on innovation, although numerous studies point out that destructive leadership affects organizational performance. However, such literature pays little attention to the relationship between destructive leadership and innovation. This study uses an online survey of 210 employees from 80 Portuguese firms in different sectors, to test the effect of destructive leadership on behavioural innovation and how a caring climate influences such relationship. The analysis uses multiple linear regressions to test the hypotheses. Findings reveal that destructive leadership has a negative effect on innovation and on caring climate. The results show that a caring climate influences innovation in a positive way that mitigates the relationship between destructive leadership and innovation.

Keywords: Destructive leadership; organisational innovation; behavioural innovation; organisational climate; caring climate; mitigation effects

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1. Introduction

Leadership is one of the most important factors affecting organisational innovation. Literature supports a positive link between these two variables (e.g., Denti & Hemlin, 2012). However, there is also a dark side to leadership. Leaders can behave in a destructive way towards subordinates that negatively affect their motivation (Deci et al., 1989) and promote a work climate replete with hostilities and constraints that hinder or block organisational innovation. The research on the effects of destructive leadership on innovation is still limited (Denti & Hemlin, 2012). Approaching leadership through a negative lens indicates that a leader may have a destructive behavior which discourages innovative challenges, the exploration of new solutions or engaging in creative endeavours (e.g., Lee et al., 2013; Colquitt, Scott & LePine, 2007).

In addition to its decisive role in organisational innovation, leadership also plays a key role in shaping the organisational climate (Akkermans et al., 2008), which influences directly or indirectly the employees' attitudes and behaviours. The literature describes the ethical climate in an organization as the procedures, policies, and practices that have an “ethical content” (Victor & Cullen, 1988). Ethical climate can influence a number of organisational outcomes, such as innovation, although limited research has directly addressed such a correlation (Choi et al., 2013; Gonzalez-Padron et al., 2008). More research is needed to understand “how” leadership is related to innovation and what factors can mitigate that relationship. Leaders can boost or reduce organisational creativity and innovation. Lee et al. (2013) analysed the relationship between abusive leadership and the creativity of employees and concluded that those who are exposed to very high levels of abusive leadership tend to be less creative. Leadership affects innovation because it can create a work environment where employees are encouraged to freely discuss and try new ideas

and different approaches (Amabile et al., 1996). Thus, an ethical climate can be a mitigating variable between leadership and innovation (e.g., Mayer et al., 2010).

This study aims to contribute to the stream of research on destructive leadership (e.g., Krasikova, Green & LeBreton, 2013; Schyns & Schilling, 2013; Shaw, Erickson & Harvey, 2011) in two ways. One is by analyzing its effects on behavioural innovation, and the other is by introducing the caring climate – a specific type of ethical climate – as a mitigating variable of such effects.

2. Destructive leadership and organisational innovation

Emphasising the positive side of leadership fits within the positive organisational behaviour framework that literature has produced in recent years (e.g., Denti & Hemlin, 2012). However, the destructive leadership must not be neglected. Several studies have addressed this topic coining destructive leadership as “aversive” (Thoroughgood, Huntr & Sawyer, 2011) or “bad” (Schyns & Schilling, 2013), for example. Since destructive leadership is a fairly common problem in many organisations (Schyns & Schilling, 2013) and subordinates will experience it at some point in their careers (Aasland et al., 2010), “understanding and preventing destructive leadership may be as important as, or even more important than, understanding and enhancing positive aspects of leadership” (Einarsen et al., 2007, p. 208).

This study adopts the definition of destructive leadership by Einarsen et al. (2007, p. 20): “The systematic and repeated behaviour by a leader, supervisor or manager that violates the legitimate interest of the organisation by undermining and/or sabotaging the organisation's goals, tasks, resources, and effectiveness and/or the motivation, well-being or job satisfaction of subordinates”. The characteristics and behaviours usually associated with destructive leadership include acting in a hostile manner towards subordinates, annoying and inconsistent

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behaviour, inability to listen to others, inability to delegate and prioritise, showing favouritism and acting differently towards different people, controlling behaviour, or inability to develop and motivate subordinates (Shaw et al., 2011).

Along this line, Padilla et al. (2007) propose an integrated approach to destructive leadership that entails three elements that form a “toxic triangle”: leaders, followers, and environment. Consequently, destructive leadership drives not solely from a dysfunctional leader, but also from the confluence of destructive leaders interacting with vulnerable subordinates and conducive environments. The reason why subordinates accept a controlling and destructive leader is related to their need for security, a sense of group belonging, and some stability in an unpredictable world. In turn, the indicators of a caustic environment are: instability, perceived threats, corrosive cultural values, and a lack of control mechanisms.

Personality traits play also an important role when describing destructive leadership (Krasikova et al., 2013). Recent literature refers narcissism (e.g., Reina, Zhang & Peterson, 2014), Machiavellianism (e.g., Wisse & Sleebos, 2016) and psychopathy (e.g., Boddy, 2014). In addition, leaders are more likely to express destructive traits when the organisational context allows them to do so. An acid environment “communicates” to people that such behaviours are acceptable (e.g., leaders who manifest these behaviours do not suffer any consequences) and that destructive leadership is the most effective way of achieving the objectives (e.g., established rewards systems value results over ethical conduct).

One can imagine the serious consequences of destructive leadership for organisations and the negative effects it could have on subordinates. Several studies report a significant decrease in psychological well-being, individual performance, job satisfaction, self-confidence, and motivation (e.g., Schyns & Schilling, 2013). The damaging consequences for organisations include: high turnover, high absenteeism, and low organisational commitment (Schyns & Schilling, 2013). Research focusses primarily on the impact of a destructive leader on subordinates. But additional research on the consequences of destructive leadership at the organisational level is required (Martinko et al., 2013). Filling in this lacuna is especially relevant and urgent because the organisational outcomes of a destructive leadership may be linked to the lack of organisational success, threatening organisational survival.

Destructive leadership can jeopardise organisational innovation, among other organisational outcomes. The literature shows that the leader is a key element in promoting organisational innovation (e.g., Denti & Hemlin, 2012). Addressing leadership from a negative perspective means accepting that destructive leaders can prevent innovation, the development of new solutions, and engaging in creative endeavours. Subordinates may fear negative consequences of choices, and this is potentially harmful for organisational innovation, since innovation typically requires making risky decisions (Colquitt, Scott & LePine, 2007). Destructive leadership actively constrains employees from learning by error, whereas positive leadership promotes a receptive attitude to accept and learn from errors (e.g., Lee et al., 2013).

This study follows the definition of organisational innovation by Wang and Ahmed (2004, p. 2): “to open up new markets by combining strategic direction with innovative behaviours and processes”. According to these authors, behavioural innovation reflects a sustained behavioural openness to change and thus towards innovation. Destructive leadership seems to limit or restrict the organisation’s ability to innovate. A leader exerting great pressure on subordinates negatively affects their willingness to suggest new ideas for a product or service. Such a leader is not able to recognise good business opportunities, neither is he/she able to ensure the success of a company’s products in the marketplace. Consequently,

H1. Destructive leadership is negatively related to behavioural innovation.

3. The caring climate

An ethical climate is a specific type of an organizational climate. According to Martin and Cullen (2006, p. 177), an ethical climate involves “the perception of what constitutes correct behaviour, and as such, it becomes the psychological mechanism by which the ethical issues are managed”. The concept includes a set of procedures, policies, and organisational practices that have moral content and consequences (Victor & Cullen, 1988). Thus, the ethical climate influences the decision-making and behavioural responses to ethical dilemmas and, as a consequence, it is reflected in many organisational outcomes (Simha & Cullen, 2012). Victor and Cullen’s seminal works on this topic proposes an empirically tested typology of ethical climates, based on two dimensions: (a) “ethical criterion”, grounded in the dominant moral philosophy in decision-making, includes egoism, benevolence, and principle; (b) “locus of analysis”, used in reaching decisions, includes individual, local/organizational, and cosmopolitan.

The “caring climate” is one of the nine climates identified and is the only one considered in this study. Caring climate is related to benevolence (ethical criterion), both individual and organizational (locus). When organizations have this type of climate, decision-making is based on care and concern for the welfare of others. The caring climate tends to discourage destructive behaviours since it is focused on the decisions that result in the best for everyone in the organisations. The leaders’ behaviours establish, directly and indirectly, the ethical climate of organisations through encouragement, rewards, or actions (Grojean et al., 2004). The leader is a role model capable of influencing the ethical conduct of employees (Dickson et al., 2001). Caring climate tends to encourage those behaviours that result in what is best for the majority of people in organisations. Generally, caring climates are the most preferred ones (Victor & Cullen, 1988). Thus:

H2. Destructive leadership is negatively related to a caring climate.

The caring climate can influence many organisational outcomes, including innovation. Although the research has considered organisational climate to be a determinant of innovation, few studies examine the relationship between a caring climate and organisational innovation (Choi et al., 2013; Gonzalez-Padron et al., 2008). Deshpande (1996) concludes that a caring climate has a positive effect

on employees' satisfaction with their supervisors. Choi et al. (2013) report that a caring climate is positively related to organisational innovation. Therefore:

H3. Caring climate is positively related to behavioural innovation.

Mayer et al. (2010) point out that the ethical climate can have a mitigating role in the relationship between ethical leadership and employees' behaviour. Thus, when leaders adopt an ethical behaviour (i.e., they show integrity, fairness, reliability and concern for others), they create a supportive environment for a high caring climate. Accordingly:

H4. Caring climate mitigates the relationship between destructive leadership and behavioural innovation.

4. Methods

4.1 Sampling and Procedures

To test the hypotheses, we used a convenience sample of 210 employees from 80 Portuguese companies from the services sector (50 firms) and the industry sector (30 firms). The majority of employees is female (59%), 32 years old on average and having completed 15.9 years of schooling, nine years of tenure, and no experience in leading a team (82%). All respondents were asked to fill in a questionnaire with measures of destructive leadership, ethical climate, and organisational innovation. They were asked to respond bearing in mind their leader. (See Table 1 for results for demographics issues.)

Table 1: Descriptive statistics

	M	S.D.	1	2	3	4	5	6	7	8	9	10	
1. Age (years old)	32.2	8.99	1										
2. Gender	0.59	0.49	-0.182**	1									
3. Marital status	0.72	0.44	-0.468**	0.123	1								
4. Number of years at school	15.9	3.46	-0.406**	0.077	0.329**	1							
5. Tenure (years)	9	8.4	0.863**	-0.158*	-0.375**	-0.347**	1						
6. Behaviour innovation	4.01	1.38	-0.059	-0.05	0.148*	0.142*	0	1	(0.85)				
7. Poor management	3.19	1.52	0.007	0.085	-0.087	-0.097	-0.027	-0.576**	1	(0.97)			
8. Abusive Behaviour	3.18	1.58	0.047	0.094	-0.076	-0.165*	-0.021	-0.552**	0.828**	1	(0.96)		
9. Inadequate communication	3.37	1.62	-0.023	0.115	-0.069	-0.084	-0.08	-0.449**	0.766**	0.721**	1	(0.89)	
10. Caring	3.71	1.32	-0.088	-0.06	0.125	0.082	-0.089	0.739**	-0.540**	-0.511**	-0.462**	1	(0.95)

Note: ** $p < 0.01$; * $p < 0.05$; Dummies: Marital (0=married; 1=not married). Gender (0= Masculine; 1= Feminine). α in brackets. N=210

4.2 Measures

We used a multi-item questionnaire with a Likert 7-point scale where "1 = strongly disagree" and "7 = strongly agree" to assess the constructs: *Destructive Leadership*, *Organisational Innovation*, and *Ethical Climate*. To measure destructive leadership, we used a reduced version of the questionnaire of Shaw et al. (2011) and May and Meier (2013). This questionnaire presents 49 items related to leadership behaviour, including: *abusive behaviour* addressing to counterproductive work behaviors (May & Meier, 2013) (24 items) ($\alpha = 0.96$), *poor management* (21 items) ($\alpha = 0.97$), and *inadequate communication of expectations* (4 items) ($\alpha = 0.89$). Respondents were asked to indicate to what extent they agree or disagree with each statement about their current leader. Sample items of *abusive behaviour* include "When my boss makes a mistake he or she rarely corrects it" and "My boss spends too much time promoting him/herself", of *poor management* include "My boss is a poor negotiator" and "My boss

is unable to prioritize very well"; and *inadequate communication* "I rarely know what my boss thinks about my work" and "I often have to guess what my boss really expects of me". To measure *organisational innovation*, we used Garcia's (2011) adaption of Wang and Ahmed (2004) – *behavioural innovation* (5 items) ($\alpha = .85$). A sample item in this measure is: "We are continuously improving our management process". Finally, to measure *ethical climate*, an adapted version (Rego, 2001) of the questionnaire proposed by Cullen et al. (1993) was used addressing *caring climate* (10 items). A sample item of this measure includes "The decisions are taken in order to benefit all". Respondents were asked to describe how things happen in their organisations. Following Podsakoff et al. (2003), several measures were taken when preparing the questionnaire to reduce the common method variance bias (CMVB). Techniques used for detecting CMVB confirm the absence of bias.

5. Results

5.1 Hypothesis Testing

To test the research hypotheses, we used a multiple linear regression model. Table 1 presents the descriptive data and the internal consistency

of the scales. Table 2 reports the regression results showing destructive leadership (poor management, abusive supervisor behaviour, and inadequate communication of expectations) has a negative relationship with behavioural innovation and a negative relationship with a caring climate as well. Therefore, evidence supports H1 and H2.

Table 2: Regression results from testing the influence of destructive leadership in behavioural innovation and caring climate

Variables	Behavioural innovation		Caring climate	
	β	R ² Adjusted	B	R ² Adjusted
Poor-management	- 0.58**	0.329	-0.54**	0.289
Abusive behaviour	- 0.55**	0.302	- 0.51**	0.258
Inadequate communication	- 0.45**	0.197	-0.46**	0.210

β = Standartized Betas ** p <0.01;

Further, the results show that a caring climate has a positive relationship ($\beta=0.74$, p <0.01; R² Adjusted= 0.543) with behavioural

innovation. Thus, findings support hypothesis H3. Table 3 shows that a partial mitigating effect exists, which partially support H4.

Table 3: Mediation effect of the caring climate in the relationship between destructive leadership and behavioural innovation

		Step 1	Step 2		Step 1		Step 2		Step 1		Step 2	
Variables		P-M	P-M	C	AB	AB	C	IC	IC	C		
Behavioural innovation	β	-.58**	-.25**	.60**	-.55**	-.24**	.62**	- .45**	-.14**	.68**		
	R ² Ajustado	0.329	0.586		0.302	0.583		0.197	0.556			
Mediation effect		Partially Present			Partially Present			Partially Present				

β = standartized betas. ** p <0.01,

P-M – poor-management, C – caring, AB – abusive behaviour, IC – inadequate communication

6. Discussion

Our findings indicate that destructive leadership has a negative effect on employees' ability to adopt new ways of doing things, and thus it can prevent the formation of an innovative culture in organisations. This study shows that destructive leadership negatively affects behavioural innovation, since leaders that act in a harmful manner discourage their subordinates to think creatively and to try new things. This conclusion is in line with previous reported studies (e.g., Lee et al., 2013; Colquitt, Scott & LePine, 2007).

The results show that destructive leadership is negatively associated with a caring climate. Assuming that a caring climate reflects an environment that obliges that decisions should take "the best for everyone" into consideration, decisions against such principle are seldom accepted. The study shows that within a caring climate context, destructive leadership has less chance of surviving. It appears that an organization sharing generous norms prevent the emergence of destructive leaders, through nurturing a caring climate.

By presenting a positive relationship between the caring climate and behavioural innovation, consistent with Choi et al. (2013), the results point out that a caring climate facilitates an innovation supportive environment. The combined analyses between the negative relationship between caring climate and destructive leadership, on the one hand, and the positive relationship between caring climate and behavioural innovation, on the other, reinforce the importance of promoting a caring climate as a fundamental organizational environment. Aiming to provide evidence in support of this proposal, this research contributes to literature by exploring the mitigating effect of the caring climate on the relationship between destructive leadership and behavioural innovation.

According to the literature (Thoroughgood et al., 2011; Padilla et al., 2007), simply researching on the consequences of destructive leadership is not enough. It is also important to understand the context that frames "how" destructive leaders influence innovation (Denti &

Hemlin, 2012). By exploring the mitigating effect of the caring climate on the relationship between destructive leadership and behavioural innovation, this study is valuing the context that frames “how” destructive leaders influence behavioural innovation. The results confirm the mitigating effect, showing that if an organization is focused on taking decisions for the best of everyone, then the negative impact on behavioural innovation of a destructive leader is attenuated.

7. Conclusions and implications

The main contribution of this study regards the identification of negative consequences of destructive leadership on behavioural innovation. Since the capability to innovate influences the long-term competitiveness of organisations, such results show that destructive leadership can damage the organisation's competitive position. The results show that destructive leadership affects the ethical climate in general and a caring climate favorably influences behavioural innovation. Climate is an important antecedent to behavioural innovation. The literature supports the positive relevancy of a caring climate for several outcomes (e.g., job satisfaction and organizational innovation) and this study specifically adds to it by presenting the caring climate as a suppressor of the destructive leadership effects. Such an effect serves organisational competitiveness.

The study findings are two folded, both for academics and practitioners. Academia can benefit from the research outcomes. Although several previous studies have examined the impact of leadership styles on innovation, this study addresses the consequences of destructive leadership on innovation in Portuguese firms from different sectors. The study further explores the mediating effect of the caring climate in the relationship, enlarging the knowledge on destructive leadership. Practical implications apply to recruitment, training and development of leaders. Organisations should avoid hiring destructive leaders and should develop training programmes for making leaders more aware of the effects of their behaviour on innovation. A better understanding of the nature and consequences of destructive leadership could well enable organisations to identify this type of behavior, and to thus intervene as early as possible.

8. Limitations and Future Research

This research contributes to the enhancement of the body of knowledge on the underlying relationship between destructive leadership and organisational innovation. Although we have tested and expanded our understanding of the theory by using less explored relations, some limitations should be noted. This research uses cross-sectional data which limits the conclusions about causality. Restrictions to generalisation also apply due to the nature of the group of firms involved in the study. Whereas we account for a collection of industry and service firms, we do not control for other relevant organisational variables which might influence leadership patterns and the organisation's capability to innovate. These variables include size, geographic location, international experience, corporate membership, and family business.

Moreover, we obtain all of our data from self-reported questionnaires, which might impose some constraints. Some participants may have answered the questions in a socially desirable manner, rather than disclosing their real opinions. Further research can make use of objective measures (e.g., direct observation) to capture the real behaviour of leaders. Finally, we only analyse the perceptions of subordinates about their direct supervisors. The perceptions of subordinates can be influenced by other factors not considered in this study (e.g., personality traits, the quality of leader-subordinate relationship, and performance appraisal systems). Future research could collect matching data from different sources for comparison purposes.

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Towards Innovation in Multinational Corporation Subsidiaries: Development of an Instrument to Select and Evaluate Value Driven Strategies

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Abstract: This paper examines the complex, interdependent relationship between multinational companies and their subsidiaries. It discusses how subsidiary role development and specific strategic initiatives may add new value to corporations. While previous studies have identified the need for more proactive management practices, there are few practical guides available to managers to help them improve their performance. This paper addresses this deficit and contributes new knowledge on subsidiary role development practices in terms of selection and evaluation. Through an in-depth analysis of extant literature, the research developed and tested an instrument that allows decision makers to assess their company against good practice. This instrument (or audit tool) is an accurate, reliable and valid mechanism to measure a subsidiary's role development strategies.

Keywords: Multi-national corporation; subsidiary; strategy selection and evaluation; best practice analysis; scorecard

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Introduction

Subsidiaries of multinational companies (MNCs) play a vital role in the modern economy. A subsidiary can be defined as “any operational unit controlled by the multinational company and situated outside the home country” (Birkinshaw, 1997, 207). Bouquet and Birkinshaw (2008a) showed that while subsidiaries are dependent on their corporate parent they also have sources of power and influence. The conventional belief of viewing the foreign subsidiary as a subordinate entity within the MNC has been the subject of continuing debate in management literature. Many researchers argue that managing a subsidiary effectively is not simply about carrying out the narrow mandate prescribed by the parent; but rather it is about fulfilling the current mandate in a superior way and pursuing strategic initiatives that add new value to the corporation (Delany, 2000). In this regard, subsidiaries become innovators in a fully integrated network (Di Minin and Zhang, 2010). Cantwell and Mudambi (2005) refer to this as a “competence-creating” role.

Subsidiary role development has been described by researchers “as a change in the product, value-added and market scope of a subsidiary” (Dörrenbächer and Gammelgaard, 2006, p. 267). The development of the role of a subsidiary has also been described as moving from “doing only what is expected” to “doing what also makes good business sense” (Sargeant, 1990, as cited in Delany 2000, p. 227). Researchers have investigated this advancement and generated typologies to help our understanding in this regard (Hansen et al., 2011; Delany, 2000). For example, Delany's (2000) research proposed an eight stage model for advancing the development of a subsidiary from fulfilling a basic mandate through to that of a strategic independent entity. Thus the subsidiary develops by building on previous achievements such that each step is a progression of the existing mandate. Progression through each of these stages demands that the subsidiary consciously and proactively develop a strategy to add value. Some of these

strategies include value chain migration (Fennelly and Cormican, 2006), initiative taking (Birkinshaw and Fry, 1998; Delany, 2000; Tseng et al., 2004), courting headquarters attention (Birkinshaw et al., 2006; Bouquet and Birkinshaw, 2008b), embedding itself within the multinational company (Heidenreich, 2012), gaining autonomy from headquarters (Paterson and Brock, 2002), and subsidiary entrepreneurship (Birkinshaw, 1997; Scott et al., 2010).

While the literature details diverse approaches that can be taken in order to develop the role of the subsidiary we find that much of this is prescriptive. We argue that it is essential to adopt a more open and discursive approach in order to explore and improve current practices. In reality, organisations require an integrated suite of options that they can tailor to their needs. In light of this our study seeks to understand current work practices in real world operational settings that promote value adding strategies. The research is descriptive rather than prescriptive. We provide narratives of the value added practices and derive an explanatory framework to enable a more empirical analysis of these practices. Thus the main contribution of this paper is the development of an instrument that can be used to allow organisations to assess themselves against good practice as defined by the literature. As the underlying framework is explanatory rather than categorical we describe practices and perspectives that overlap as well as interact. In other words, best practice items are presented for analytic clarity and convenience rather than as an ontological separation. The instrument is then validated for levels of accuracy, validity and reliability by a sample of 108 respondents. Findings from this analysis are presented.

Initiatives to add value

According to Schmid et al., (2014), subsidiary initiatives are proactive, autonomous and risk-taking activities that originate outside the home country in a foreign subsidiary of a Multinational Corporation

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(MNC). These value driven initiatives are taken in order to advance or evolve the role of the subsidiaries. They are, by definition, entrepreneurial activities. These efforts can strengthen the subsidiary mandate within the MNC network by means of value-adding activities. This can lead to greater autonomy for the subsidiary resulting in control over the development of new products, manufacturing process, penetration of new markets or simply the generation of new ideas that have applications for other parts of the global organisation.

However, subsidiary initiative taking was recently labelled a “troublesome and little-understood concept” (Ambos et al., 2010, p.1100). The literature also provides evidence of intra-organizational conflict between headquarters and subsidiaries concerning the issue (Blazewski and Becker-Ritterspach, 2011; Schotter and Beamish, 2011). Some studies have found that subsidiary managers’ motives and interests are not necessarily aligned with those of the MNC (Ambos and Schlegelmilch, 2007; Boussebaa, 2009). In other words, subsidiaries may seek to advance their role in such a way that it conflicts with the overall strategy of the MNC. In light of this, obstacles may lie in the path of subsidiaries who try to pursue new initiatives. It has been noted that local initiatives can be either applauded or condemned by headquarters as oftentimes initiatives are seen as empire building. To this end Birkinshaw and Fry (1998) state that the “combination of outright opposition, internal competition, and passive indifference are a challenging set of obstacles for the initiative champions” (Birkinshaw and Fry 1998, p. 54). Consequently, it may be challenging to ensure that essential and sufficient resources are available to implement their strategies.

Many studies have examined initiative taking as a means of achieving the added value required for subsidiaries to progress in their role (Hansen et al., 2011; Wang and Suh, 2009). Suggested approaches to increasing the legitimacy of the subsidiary can be categorised under two broad approaches; (a) enhancing the subsidiaries profile and (b) pursuing new opportunities. Enhancing the profile focuses on improving credibility, image and reputation within the MNC and showcasing the unique factors of the subsidiary. Identifying and pursuing new opportunities may include developing new products and processes, moving into strategically important markets and establishing collaborative partnerships with other peer subsidiaries (Bouquet and Birkinshaw, 2008). Conducting research and development is a highly regarded method of securing role development. Mudambi et al., (2007) established the link between research and development output, as calculated by the number of patent citations and “increased subsidiary self-determination and enhanced teamwork” (Mudambi et al., 2007 p. 453). Delany (2000) concurs with this view, asserting that the multinational company will benefit from supporting and facilitating initiative taking at the subsidiary as it maximises the benefits of its skills and expertise. However, he warns that subsidiary initiative taking is only a successful long-term strategy for the subsidiary if it results in value-added activities contributing to the operations of the parent MNC. Reilly et al., (2012) also believe that subsidiaries should align their initiatives with the strategy being pursued by headquarters. This maximises transparency between headquarters and the

subsidiary ensuring trust and confidence is developed. Thus a “mutually interdependent relationship is enabled which facilitates incremental subsidiary growth” (Reilly et al., 2012, p. 9).

There is no consensus among researchers as to the best way to pursue subsidiary initiative taking in order to secure role development and high value added activities however several schools of thought exist on how to pursue it. After a synthesis of the literature we identified four potential strategies for subsidiary role development. These factors are descriptive and explanatory and are not mutually exclusive. Thus when considered together they form the basis of an integrated framework to guide practitioners in their quest to advance or evolve their role.

Fulfil the mandate

Paterson and Brock, (2002) assert that mandates of MNC subsidiaries have evolved as a distinct field of research and many studies have been conducted in this domain. For example, Zeschky et al., (2014) examine the types and levels of mandates in a MNC environment while Hansen et al., (2011) empirically investigate the evolution of mandate trajectories in developing economies. Many studies explore how the host country environment shapes mandates of subsidiaries (Bevan et al., 2004; Luo, 2005). More recently Sofka, et al., (2014) have considered how knowledge is protected in this environment.

Mitchell et al., (1997) posit that “power, legitimacy and urgency” are important to ensure that subsidiaries are seen as worthy of attention. Fulfilling a mandate well helps a subsidiary to achieve legitimacy and is a powerful tool in role development. The literature contends that subsidiaries should fulfil the mandate specified by headquarters to the very best of their ability (Hansen, et al., 2011; Reilly et al., 2012). For example, Birkinshaw et al., (2006) state that it is important to “be a good citizen” and delivering what is required is a good way of achieving this. Reilly et al., (2012) takes this a step further and states that not only should subsidiaries fulfil the mandate but they should ensure that they are compliant with the strategy of headquarters and pursue all opportunities that align with this strategy.

However, fulfilling the mandate and maintaining compliance with headquarters’ mandate while important is not sufficient to ensure role development. Researchers emphasise the importance of finding ways of taking control; this involves finding ways of working outside of the formal structure of the multinational company and involves a higher levels of risk (Bouquet and Birkinshaw, 2008a). Fennelly and Cormican (2006) explored value chain migration in Irish medical device companies. Their work described “charter extension” as a method of role development; they found that in order to achieve this, the subsidiary must not only do the job assigned to them but also be proactive in making headquarters aware of their key capabilities and skills.

Leadership

The literature provides evidence to suggest that there is often tension or conflict between leadership in the subsidiary and leaders in headquarters in the MNC (Blazewski and Becker-Ritterspach, 2011; Boussebaa, 2009). However, Schotter and Beamish, (2011) assert that

research has “struggled to acknowledge the magnitude and complexity of intra-organizational conflict coordination” and the “roles that individual managers play” (Schotter and Beamish, 2011, p. 243). Leaders in the subsidiary are often motivated to evolve the role of the subsidiary into a more innovative and value adding entity (Ambos and Schlegelmilch, 2007) while leaders in the headquarters are eager to ensure that subsidiaries concentrate on fulfilling their mandate.

To move towards value adding initiatives it is imperative that managers shift their mind-set from one of subservience to the corporate headquarters to one of initiative taking in order to exploit its importance within the multinational company network (Delany 2000). Birkinshaw and Fry (1998) found that subsidiaries that are successful in developing new roles have a champion with the talent to identify this business opportunity and drive it forward. Many other authors suggest that leaders should adopt an entrepreneurial perspective and become catalysts for change (see Garcia-Pont et al., 2009; Yamin and Andersson, 2011). To this end the literature provides evidence to show that leaders in subsidiaries have forged independent relationships within and beyond the corporate network to explore and exploit potential innovative opportunities (Di Minin and Zhang, 2010; Schotter and Beamish, 2011; Jindra, et al., 2009). Other entrepreneurial leaders have developed ideas using subsidiary resources without headquarters knowledge and then presented these developments to headquarters once they have demonstrated their viability (Birkinshaw and Fry, 1998; Delaney, 2000).

Attention seeking

Subsidiaries must publicise their strengths and capabilities to headquarters in order to gain attention. Researchers have looked at how to attract attention or sell issues to management (Dutton and Ashford, 1993) and the importance of this communication to the strategic direction of the multinational company and the overall competitiveness (Dutton et al., 1997). The relationship between the subsidiary and headquarters is essential in gaining attention for the subsidiary. Strategic isolation is often a problem for subsidiaries which are based far from headquarters and whose abilities do not form a strategically important part of the value chain or are not in a strategically important section of the value chain (Bouquet and Birkinshaw, 2008b).

Birkinshaw et al., (2006) categorised attention as a resource into three groups “top down or bottom up”, “directive or supportive” and “instrumental”. Top down or bottom up is a straightforward method of communication, either it is sought by subsidiary management (bottom up) or is part of the formal review structure, e.g. annual reviews, metrics (top down). Directive or supportive refers to the extent to which the headquarters may be looking to learn about the subsidiary (supportive) or due to concerns it may have (directive). Instrumental refers to internal communications, and symbolic refers to communications to stakeholders. Birkinshaw et al., (2006) posit that bottom up, supportive and symbolic are the types of attention that a subsidiary should strive to achieve.

It is important to note that the overarching goal of attention seeking is to gain an advantage rather than having an adverse effect on the subsidiary. Bouquet and Birkinshaw (2008b) noted that excessive attention can have a negative impact, leading to an overestimation of the performance of the subsidiary and placing an unnecessary burden on resources. Ambos et al., (2010) found that in order to succeed, subsidiary initiatives required attention, however this attention in turn negatively affected the autonomy of the subsidiary. Although overall, pursuing initiatives seems to be more beneficial to the subsidiary than staying below the radar.

Autonomy

Birkinshaw and Hood, (1998) posit that subsidiaries should have some level of autonomy over their decision making and resources. However, in practice, different types of subsidiaries enjoy different levels of autonomy (Persaud, 2005). Zeschky et al., (2014) propose a typology that identifies four levels of autonomy in R&D subsidiaries. They argue that the degree of technology and market orientation influences the type of mandates and level of autonomy. According to Young and Tavares, (2004) the level of autonomy experienced by the subsidiary depends on the degree to which decision making is centralized. While the subsidiary seeks for more autonomy oftentimes the MNC is eager to maintain a tight control over decisions and resources as they fear that too much autonomy will lead to empire building and maverick management teams pursuing pet projects that do not align with corporate strategy (Paterson and Brock, 2002).

Other researchers link the level of autonomy granted to trust between the subsidiary and headquarters. This trust is usually gained by fulfilling a mandate well (Bouquet and Birkinshaw, 2008a; Delany, 2000; Mitchell et al., 1997). Tavares and Young (2006) assert that subsidiaries can develop and leverage distinct capabilities and thereby alter their role and mandate within the MNC organization.

Research Methodology

Developing the instrument

A deductive methodology was used in this study in order to provide an empirical estimate of each theoretical determinant. The approach taken to developing the instrument was based on that used by Voss et al., (1994) and DeVellis (2012). This process begins with the development of a model that is grounded in best practice literature and then operationalizing this through specific tangible items that can assess current versus best practice. Worthington and Whitaker, (2006) posit that it is inherently difficult to measure that which is ill-defined therefore it was essential to start with a clear conceptual understanding of our model. This model of value adding strategies was developed using a top down approach. It comprised a detailed synthesis of the relevant literature which enabled us to identify and classify four core elements from the overall conceptual framework i.e. (a) Fulfilling the mandate, (b) Leadership, (c) Attention seeking, (d) Autonomy. Subsequently a bottoms-up approach was used to develop specific statements which characterised best practice in each of the categories based on the literature (Chisea et al., 1996; Voss et al., 1994). Table 1 presents

these statements. Likert-type scales are one of the most commonly used item formats in to gauge levels of agreement with an item (DeVellis, 2012; Allen and Seaman, 2007). Consequently this was employed in our study in order to allow potential respondents to assess the

level of importance for each item. In order to avoid extremes and to allow for a greater differentiation a five point Likert scale was used to assess the extent to which an individual agrees or disagrees with each statement.

Table 1: Items on the scorecard

Item measured	Supported by
The subsidiary does not just what is expected by headquarters but what makes business sense	Achcaoucaou et al., 2014; Bouquet and Birkinshaw, 2008a; Bevan et al., 2004; Luo, 2005; Sargeant, 1990
The subsidiary builds on previous achievements such that each step is a progression of the existing mandate	Zeschky, et al., 2014; Hansen et al., 2011; Balogun et al., 2011; Delany, 2000
The subsidiary fulfils the mandate of the company e.g. manufacturing excellence	Reilly et al., 2012; Hansen, et al., 2011; Mitchell et al., 1997
Headquarters recognise the subsidiary for its potential contribution to innovation and new ideas	Fennelly and Cormican, 2006; Birkinshaw and Hood, 2001
The subsidiary delivers on its key responsibilities	Reilly et al., 2012; Fennelly and Cormican, 2006, Mitchell et al., 1997
The subsidiary's leadership team defines the local strategy	Birkinshaw et al., 2006; Delany 2000
The subsidiary's leadership team spends significant time building relationships within and beyond the corporate network	Schotter and Beamish, 2011; Di Minin and Zhang, 2010; Jindra, et al., 2009; Cantwell and Mudambi, 2005
The subsidiary's leadership team acts in an entrepreneurial way and is a catalyst for change	Yamin and Andersson, 2011; Garcia-Pont et al., 2009
The subsidiary looks at ways of increasing its bargaining power	Schotter and Beamish, 2011; Birkinshaw et al., 2006
The subsidiary's leadership team actively pursues strategic initiatives which go beyond the mandate dictated by headquarters	Bouquet and Birkinshaw, 2008a; Fennelly and Cormican, 2006; Delany, 2000
The initiatives pursued by the subsidiary's leadership team at the subsidiary add value to the organization as a whole	Reilly et al., 2012; Delany, 2000
The subsidiary's leadership visits other corporate sites in the network	Delany, 2000
The subsidiary's leadership team pursues initiative taking rather than solely implementing headquarters defined strategies	Yamin and Andersson, 2011; Garcia-Pont et al., 2009, Birkinshaw et al., 2006
The subsidiary is proactive in making headquarters aware of its key capabilities and skills	Fennelly and Cormican, 2006
The subsidiary's leadership team looks for attention from headquarters in order to gain an advantage	Birkinshaw et al., 2006; Dutton et al., 1997
The subsidiary's leadership team designs strategies that allow the subsidiary to influence the amount and type of attention they receive from headquarters	Birkinshaw et al., 2006, Dutton et al., 1997
Headquarters supports initiative taking at the subsidiary	Wang and Suh, 2009; Delany, 2000
The subsidiary takes risks with the aim of increasing its importance within the multinational network	Schmid et al., 2014; Ambos et al., 2010; Bouquet and Birkinshaw, 2008a
The subsidiary pursues activities in its local market e.g. looking for opportunities with local suppliers, partnerships with local universities etc.	Cantwell and Iguchi, 2005; Birkinshaw, 1997; Ghoshal and Bartlett, 1990
The subsidiary enhances the way the multinational organisation learns e.g. sharing skilled employees, lessons learned, transferring knowledge	Sofka, et al., 2014; Tavares and Young, 2006; Birkinshaw, 1997
The subsidiary works outside the formal structure of the multinational company e.g. projects are implemented without formal reviews from headquarters	Ambos et al., 2010; Bouquet and Birkinshaw 2008
Resources are made available by the subsidiary's leadership team to allow initiative taking by employees	Birkinshaw et al., 2006
The subsidiary has a high level of autonomy over its decision making	Zeschky, et al., 2014; Birkinshaw et al., 2006; Young and Tavares, 2004
The subsidiary has control over key strategic decisions for particular activities (e.g. R&D, manufacturing, marketing) in the value chain	Jindra, et al., 2009; Birkinshaw et al., 2006; Young and Tavares, 2004
Autonomy is targeted as an important goal for the subsidiary	Ambos et al., 2010; Birkinshaw et al., 2006

Face Validity

Validity is the primary concern in developing items for instruments. Items or statements must reflect the instruments intent (DeVellis, 2012). Poorly worded items may introduce possible sources of error variance (Worthington and Whitaker, 2006). Face validity is particularly important for unexamined scale items in particular such as ours (Hardesty and Bearden, 2004). Face validity is a subjective test which attempts to assess the extent to which an instrument actually measures the concept it purports to measure. In other words, it reviews the relevance of a test as it appears to test participants. It is lauded to have merit even though it is very subjective (Haladyna, 2004; DeVon et al., 2007). Consequently, a pilot study was conducted with experts in the area. This involved assessing the relevance and appropriateness of the proposed instrument as well as the grammar, syntax, organization, and logical flow (after DeVon et al., 2007; DeVellis, 2012). Suggestions for improvement were incorporated and edits were made to the instrument as a result.

Content Validity

Voss et al., (1994) state that content validity as an important consideration when assessing tools such as audits and scorecards. Content validity measures the degree to which a sample of items or statements, when taken together, “constitute an adequate operational definition of a construct” (Polit and Beck 2006, p. 490) or “the extent to which an instrument adequately samples the research domain of interest when attempting to measure phenomena” (Wynd et al., 2003, p. 509). The content validity ratio proposed by Lawshe (1975) formed the basis for our analysis. This method involves soliciting the opinions of subject matter experts ($n=7$) on the items in a survey. They are asked to rate each item on the scorecard from “essential”, “useful” or “not necessary” on a three point scale. According to Lawshe (1975), if more than half the reviewers indicate that an item is essential, that item has some content validity. In light of this, only items that reached this target remained on the scorecard and the remaining items were removed.

Construct Validity

Construct validity measures the internal consistency of the instrument. Internal consistency explains the degree to which the items in a survey measure a similar concept (Tavakol and Dennick, 2011). Internal consistency is derived from the correlations between different items on the same test. It is used to assess whether several items that propose to measure the same general construct (e.g. fulfil the mandate, attention seeking, leadership, autonomy) produce similar scores. Cronbach's alpha provides a method of measuring construct validity or the internal consistency of a scale (Hensley, 1999). The higher the calculated value of Cronbach's alpha the more reliable the survey (Santos, 1999). Nunnally (2010) indicated 0.7 as an appropriate reliability coefficient, although different authors have proposed different cut off points for this value, 0.7 is the most widely accepted in the literature (Nunnally, 2010; Cortina, 1993; Hensley, 1999) and consequently this value was employed in our study. To ensure that the test was applied correctly guidance from the ‘tau equivalent model’ was followed (Tavakol and Dennick, 2011).

Manufacturing subsidiaries of American MNCs operating in the Medical Device industry in Ireland were targeted to generate data to measure the construct validity of the instrument in this study. The rationale for this selection was that such organisations were operating in a comparable market with similar challenges and our goal was to maintain an element of homogeneity in the sample. Probability sampling where each member of the population had a “known and usually equal chance of being included in the survey” was used in this research (Lewis et al., 2012, p. 261). The sample was random and stratified in order to ensure that it was representative of the population and to minimise selection bias. The use of strata “ensures high homogeneity within each stratum and heterogeneity between strata” (Forza, 2002, p.165). The two strata selected were engineers/technicians/scientists and managers. Each of these strata mutually exclusive following best practice (DeVellis, 2012). Proportional allocation was not undertaken. The instrument was distributed to 750 individuals in total. The instrument was accompanied by a cover letter detailing the rationale and goals of the survey. This letter stated that the results were for research purposes only and encouraged the participants to be as open and as frank as possible in order to minimise subject bias.

The values of alpha all exceeded 0.842 suggesting a strong internal consistency among the items being examined. It essentially showed that for each construct analysed, the respondents who tended to select strongly agree and agree for one question were also inclined to select strongly agree and agree for the other questions. Equally respondents who picked strongly disagree and disagree for one question tended to select similar scores for related question/s. This illustrates the reliability of the scorecard.

Discussion

Auditing has been championed as a useful exercise by a number of authors (Voss et al., 1994; Cormican and O'Sullivan, 2003). The scorecard allows organisations to gauge where they are in relation to best practice, identifying areas in which they are performing well and opportunities for improvement (Cormican and O'Sullivan, 2003). Such practices can also provide a company with a baseline to help review the company's continuous improvement initiatives. The instrument developed is an example of academic research being used to underpin improvements in identifying issues in business and driving progress (Chiesa et al., 1996).

The scorecard was created around research-based statements (Voss et al., 1994). Each item was designed to capture best practice for subsidiaries looking to secure role development and higher value added activities. It is a tool to allow an organisation to assess current versus best practice. Using proven theoretical concepts to evaluate the scorecard improved its integrity and this research employed face validity, content validity and construct validity. Findings from this analysis lead to the modification of certain items and the removal of others.

The scorecard presented here serves as a template. In order to implement the scorecard it should be customised to the organisation in question. To do this a case analysis could be undertaken to assess

which of the strategies is being pursued and then a scorecard with only the relevant sections should be distributed. For both questions the subsidiary name must be included in order to adapt the questions to the case study organisation in question. The examples provided in certain questions should also be customised to the case study in question. For example, in question twenty six the example of manufacturing should be replaced with an example that accurately captures the mandate of the case study company being examined.

The overarching objective of this study has been to deepen our understanding of subsidiary role development. Our research analyses best practice for subsidiaries seeking to secure role development and higher value added activities in a dynamic networked environment through an open discursive perspective. Our work focused on identifying essential constructs and generating an integrated framework and operationalizing this in the form of a self-assessment instrument. This tool was then tested in a real world environment. This allows organizations to assess themselves against best practice as defined by the literature. Hence we respond to recent calls to investigate practical solutions and bridge the gap between theory and practice. From the survey results, it is clear that on the whole the instrument developed is accurate, reliable and valid. While it was specifically designed to be used as a standalone audit tool; there is potential for this survey to be rolled out across all subsidiaries in the multinational company. It could be used to benchmark both within multinational companies and between different subsidiaries and within industries. The tool can also be used to reassess the organisation once improvements have been made to establish if they have had the desired impact.

Our analysis makes important contributions to technology management research. Our findings contribute to research on subsidiary role evolution by identifying and testing critical constructs. Prior research recognizes that critical elements are essential to success and our findings add to this debate. These results allow us to advance the general theoretical development of the field and to empirically test previous explanations as to how subsidiaries of multinational corporations can generate innovative value adding strategies. These findings are useful in furthering our understanding of how implement best practice. Hence, this study is of managerial relevance to subsidiary managers. Certain limitations of this study should be noted. This study focused solely on multinational subsidiaries operating in the medical technology industry in a small open economy i.e. Ireland. Consequently, the context of this study is quite specific and the explanatory power of our findings may be limited to this particular industry or country. Future studies could strive to address this deficit.

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R&D Tax Incentives: How Do They Impact Portuguese Start-ups?

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Abstract: In this work, a comparison between start-up companies' performance is made based on the way they use the Portuguese R&D tax credit program. From the analysis of the results, it is possible to verify that companies that benefit from this program have a distinct behavior from those that do not, either in what regards financial performance, the weight of the intangible assets in the company or in what regards the quality and value added of the jobs created. It is also possible to find that beneficiary companies mix the tax credits with the use of European, national and regional grants, thus mixing the funding available to support their Research, Development and Innovation activities.

Keywords: SIFIDE; grants; start-up; Portugal; performance

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Introduction

There is a growing awareness, both by policy makers and the business sector, that Research, Development and Innovation (RDI) activities are key factors for future economic growth and sustainability. This has led countries in recent years to adopt support financing programs for such activities. These support programs usually of two types: direct support (mostly grants) and indirect support (mainly tax incentives) that can be used exclusively or cumulatively by the companies. In OECD and EU countries the tax incentives are applied generally in the form of a tax credit that is calculated with a rate applied to the companies RDI approved expenses and, in recent years, the measurement of the total RDI support to companies has verified that the tax incentive programs have been increasing their relative importance in the total volume of public support to the business sector over the direct support programs (OECD, 2018). In the Portuguese case, the RDI landscape is characterized by the existence of direct support programs, mostly provided by European programs such as Horizon 2020 and national and regional development and cohesion funds that, in the last 10 years, have been placing a special emphasis on innovation and internationalization of companies. In what concerns indirect support programs, the Portuguese government has in place since 1997 a Tax Credit Program, the SIFIDE (Fiscal Incentive System supporting R&D in Enterprises) Program that each year provides tax deductions to the expenses made on R&D activities.

A study performed in Portugal for the period 1998 thru 2010 (Carvalho, 2013), highlighted a sustainable growth of the public financing to business R&D in Portugal, and also reported an increase in the relative importance of the tax incentives over direct support. In Spain, (Corchuelo & Martínez-Ros, 2010) noticed that the knowledge on tax incentive programs was scarce by most companies, with SMEs with innovative capacity using them together with government grants. (Busom, Corchuelo, & Martínez-Ros, 2014) have reported that grants

are more suitable for firms that do not have previous R&D activity and especially to young and knowledge intensive firms whereas tax incentives help firms that already are performing R&D to continue or increase their innovative activities. Also it has already been found that tax credits have a higher effect in service start-up companies (Castellacci & Lie, 2015), but a balance between tax credits and grants must be reached in order to adjust the incentives to an optimal level (Noked, 2014). Finally, considering the mix between grants and tax benefits, (Radas, Anić, Tafro, & Wagner, 2015) report that they make a difference in SMEs, independently of the approach to the mix chosen by companies, although it is suggested that direct support is more suited to SMEs.

With this knowledge, and considering that the Portuguese entrepreneurial landscape has, in the recent years, seen the appearance of multiple technological start-ups, either promoted by qualified independent entrepreneurs or by universities and research institutes, that try to expand revenue sources by pipelining R&D thru start-ups in incubators, it is important to understand how technological start-ups (less than 10 years of age) companies use these support schemes, measuring how companies use the R&D tax credits and assessing its influence in competitiveness, as measured by a set of nine performance indicators.

As mentioned before, these questions arise from the fact that little attention was paid in literature to the Portuguese case (Carvalho, 2013; Direção Geral da Estatística da Ciência e da Educação, 2016) and the fact that, in OECD, little analysis on how the R&D tax schemes are being used, although tax generosity has been extensively studied (Balioune-Lutz, 2015; Thomson, 2012). Also, very few studies can be found on how the grants leverage R&D and innovation (Silva, 2014), although the last two Multi-annual Financial Frameworks (MFF) of the European Union have been devoted to R&D&I, either through direct RTD grants or through regional development funding, managed by national and regional development agencies.

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Method

Subjects or Participants

Since Portugal has one of the most competitive R&D tax credit schemes of OECD and considering the existing literature on the subject in what concerns small, technology oriented companies, the study focused on companies with less than 10 year of age and with a number of employees between 2 and 250, that operate in manufacturing and services knowledge intensive areas, as defined by the Eurostat (2018).

The study aims to understand how these companies use the policy mix provided by grants and tax credits to R&D and create a typical profile of companies during the last 5 years.

For that, information regarding companies provided by the SABI database (Bureau Van Dijk, 2018) was collected, systematizing information on companies in Portugal regarding its Fiscal Identification Number (NIF), its status and foundation date and, for the fiscal year of 2016, the turnover, the EBITDA, the total assets, the intangible assets, the grants received, the added value, the export volume, the total yearly expenditure on salaries and the number of employees.

Information on the use of tax credits for the years 2012 thru 2016 is made publicly available by the Portuguese Government, and it includes the tax credits claimed by companies, following the emission of a tax credit voucher, awarded by the National Innovation Agency, to companies that fulfilled the requirements of SIFIDE II and that can be used by the companies in the following five fiscal years. Companies are identified by their Fiscal Identification Number (NIF) (systematized untreated data available in <https://goo.gl/A8Sdp9>).

Crossing the information on the two sources, it was possible to identify 1523 companies that benefited at least once from SIFIDE between 2012 and 2016; of these companies, 170 cumulatively fulfilled the following requirements: have a financial statement available for the year 2016, have an incorporation date between 01/01/2007 and 31/12/2016, have between 3 and 250 employees, have an operating revenue in the year 2016 of less than 50.000.000€ and have a balance sheet in the year 2016 of less than 43.000.000€. It should be noted that the last three requirements correspond to the European Commission requirements for a company to be considered an SME. As a final filter, were selected only the companies that have a NACE code corresponding to manufacturing and services knowledge intensive areas as defined by the Eurostat. Of the 170 companies, 152 benefited from operating grants in at least one of the five years, whereas 18 did not.

Doing the same exercise for companies that did not benefit from SIFIDE between 2012 and 2016, it was identified the 10289 remaining Portuguese companies had fulfilled the same characteristics cumulatively but did not benefit from SIFIDE in the last 5 years. Of these, 5289 benefited from operating grants in at least one of the five years, whereas 5000 did not.

Design

Based on the use of tax credits by the companies in the last five years, it is possible to create two independent groups of companies:

0 - Companies that did not benefit from SIFIDE tax credits in the years 2012 thru 2016

1 - Companies that benefited from SIFIDE tax credits in the years 2012 thru 2016

So that the impact can be measured, it is necessary to have key performance indicators. Although there is no consensus on how the performance of companies can be measured, (Lumpkin & Ireland, 1988) included in the financial strengths that a young company should have, its profitability and the debt level that it presents, along with the management team skills and the marketability and uniqueness of the product/service.

In a more systematic approach, the measurements made rely on the assumption that companies must base their strengths in its financial profitability and productivity (Guo, Hotchkiss, & Song, 2011; Jain & Kini, 1994; Kaplan, 1989), presenting an effective commercial performance (Wiggins & Gibson, 2003) and leveraging their innovation on tax credits and grants provided to support innovation and technological leadership (Howell, 2017) at national and European level. Further measurement can be done so that it is verified that ensuring that each job created presents an added value to the entrepreneurial process (Sauer mann, 2016) with reasonable salaries (Botti, 2013) and with an external market orientation (Rose & Shoham, 2002).

For each group, in order to measure the performance of the companies involved, a set of indicators was developed based on company data for the year 2016:

1. Commercial performance, evaluated as the ratio between the turnover and the number of employees (01COMPER);
2. Profitability, evaluated as the ratio between the EBITDA and Turnover (02PROFIT);
3. Productivity on the use of the total assets, evaluated as the ratio between the EBITDA and the Total Assets (03PRODASSE);
4. Weight of intangible assets, evaluated as the ratio between the Intangible Assets and the Total Assets of the organization (04PRODINTA);
5. Dependency on private or public grants, evaluated as the ratio between the sum of the Grants received in the last 5 years and the Turnover in 2016 (05GRANTS);
6. Dependency on SIFIDE, evaluated as the ratio between the sum of SIFIDE tax returns in the last 5 years and the Turnover in 2016 (06SIFIDE);

7. Quality of the jobs created, evaluated as the ratio between the total yearly expenditure on salaries and the number of employees (07 EX-PEREMP);

8. Value added per employees, evaluated as the ratio between the total added value of the company and the number of employees (08 VA-PEREMP);

9. Openness of the companies to external markets, evaluated as the ratio between Exports and the Turnover (09 EXPORTURN).

Based on the fiscal number of each company, data tables were created based on the SIFIDE data and on the data available in SABI databases. This information was then crossed, and the SPSS ready .sav files were then created.

Results

Since the results provided by the dependent variables are a quantitative variable, and since the way that firms can use the tax credits leads to a nominal independent variable that defines two independent groups, where it is intended to know if the average values of the nine performance indicators are different among the two groups, a one way ANOVA test is applied.

The two groups come from a normally distributed population, where all the nine variables follow a normal distribution in all the two groups.

In the two groups, there is no relationship between its members, as such there is independence of the samples.

The companies with no tax credits registered in the last five years are a large sample (100 companies randomly chosen from a set of

10289 companies) and the companies that benefited from tax credits in the last five years is also a large sample (100 companies randomly chosen from a set of 170 companies). In these two cases the Central Limit Theorem can be applied. However, after testing for normality applying the Shapiro-Wilk test to this case, the result rejects the null hypothesis of the existence of a normal distribution and thus it is not possible to use the one-way ANOVA test.

Instead, it is used the Mann Whitney U Test for 2 independent samples.

Once again, using the initial hypothesis, it is questioned if the way that the companies use the R&D tax credits has influence in its competitiveness, as measured by a set of nine performance indicators.

Since the way that companies use the R&D incentives is an ordinal qualitative variable that ranges from 0 (did not benefit from tax credits in the last five years) to 1 (benefited from tax credits in the last five years), and since it defines two independent groups, it is applied the Mann Whitney U test.

The independence of the sample is guaranteed, since the companies that belong to each group do not have any relationship between them.

As a null hypothesis, it is defined the following:

H0: The two groups of companies, defined by the way they use R&D tax credits, have the same competitiveness performance indicators.

From the results of the test, it is possible to reject the null hypothesis in all cases, except for the one related to the productivity of assets (03PRODASSE), defined as the ratio between the EBITDA and the Total Assets of the company, as shown in Table 1.

Table 1. Statistical test of the considered variables.

	01COMPER	02PROFIT	03PRODASSE	04PRODINTA	05GRANTS	06SIFIDE	07EXPEREMP	08VAPEREMP	09EXPORTURN
Mann-Whitney U	1406.000	3469.000	4866.000	2909.000	1557.000	.000	461.000	325.000	1161.000
Wilcoxon W	6456.000	8519.000	9916.000	7959.000	6607.000	5050.000	5511.000	5375.000	6211.000
Z	-8.782	-3.741	-.327	-5.407	-8.428	-13.060	-11.091	-11.423	-9.966
Asymp. Sig. (2-tailed)	.000	.000	.743	.000	.000	.000	.000	.000	.000

Grouping Variable: BENEF

By rejecting the null hypothesis in all but one case, it is validated in all the other eight remaining indicators that the way the R&D incentives are used affects the competitiveness performance indicators of the companies.

In all cases, it is possible to find that companies that used SIFIDE tax credit in the last five years, have a tendency to become more competitive.

In more detail,

A Mann-Whitney U test was run to determine if there were differences in commercial performance score between companies that did and did not benefit from SIFIDE in the last five years. Distributions of the commercial performance (01COMPER) scores for companies that did and did not benefit from SIFIDE in the last five years were not similar, as assessed by visual inspection. Commercial performance (01COMPER) scores for companies that did benefit from SIFIDE in the last five years (mean rank = 136.44) were statistically significantly higher than for those who did not (mean rank = 64.56), $U = 1406.000$, $z = -8.782$, $p < .001$. Median commercial performance

(01COMPER) score was statistically significantly higher for companies that did benefit from SIFIDE in the last five years (71.805) than for those who did not (36.688).

A Mann-Whitney U test was run to determine if there were differences in profitability score between companies that did and did not benefit from SIFIDE in the last five years. Distributions of the profitability (02PROFIT) scores for companies that did and did not benefit from SIFIDE in the last five years were not similar, as assessed by visual inspection. Profitability (02PROFIT) scores for companies that did benefit from SIFIDE in the last five years (mean rank = 136.44) were statistically significantly higher than for those who did not (mean rank = 64.56), $U = 3469.000$, $z = -3.741$, $p < .001$. Median profitability (02PROFIT) score was statistically significantly higher for companies that did benefit from SIFIDE in the last five years (0.115) than for those who did not (0.090).

A Mann-Whitney U test was run to determine if there were differences in the productivity of assets. Distributions of the productivity of assets (03PRODASSE) scores for companies that did and did not benefit from SIFIDE in the last five years were similar, as assessed by visual inspection. Median productivity of assets (03PRODASSE) score was not statistically significantly different between companies that did benefit from SIFIDE in the last five years (mean rank = 99.16) were statistically significantly higher than for those who did not (mean rank = 101.84), $U = 4866.000$, $z = -0.327$, $p = .743$. Median productivity of assets (03PRODASSE) score for companies that did benefit from SIFIDE in the last five years (0.136) and for those who did not (0.142) was not statistically different.

A Mann-Whitney U test was run to determine if there were differences in the weight of intangible assets in the company score between companies that did and did not benefit from SIFIDE in the last five years. Distributions of the weight of intangible assets in the company (04PRODINTA) scores for companies that did and did not benefit from SIFIDE in the last five years were not similar, as assessed by visual inspection. The weight of intangible assets in the company (04PRODINTA) scores for companies that did benefit from SIFIDE in the last five years (mean rank = 121.41) were statistically significantly higher than for those who did not (mean rank = 79.59), $U = 2909.000$, $z = -5.407$, $p < .001$. Median weight of intangible assets in the company (04PRODINTA) score was statistically significantly higher for companies that did benefit from SIFIDE in the last five years (0.004) than for those who did not (0.000).

A Mann-Whitney U test was run to determine if there were differences in the dependency on private or public grants score between companies that did and did not benefit from SIFIDE in the last five years. Distributions of the dependency on private or public grants (05GRANTS) scores for companies that did and did not benefit from SIFIDE in the last five years were not similar, as assessed by visual inspection. The dependency on private or public grants (05GRANTS) scores for companies that did benefit from SIFIDE in the last five years (mean rank = 134.93) were statistically significantly higher than for those who did not (mean rank = 66.07), $U = 1557.000$, $z = -8.428$, $p < .001$.

Median dependency on private or public grants (05GRANTS) score was statistically significantly higher for companies that did benefit from SIFIDE in the last five years (0.106) than for those who did not (0.011).

A Mann-Whitney U test was run to determine if there were differences in the dependency on tax credits score between companies that did and did not benefit from SIFIDE in the last five years. Distributions of the dependency on tax credits (06SIFIDE) scores for companies that did and did not benefit from SIFIDE in the last five years were not similar, as assessed by visual inspection. The dependency on tax credits (06SIFIDE) scores for companies that did benefit from SIFIDE in the last five years (mean rank = 150.50) were statistically significantly higher than for those who did not (mean rank = 50.50), $U = 0.000$, $z = -13.060$, $p < .001$. Median dependency on tax credits (06SIFIDE) score was statistically significantly higher for companies that did benefit from SIFIDE in the last five years (0.029) than for those who did not (0.000).

A Mann-Whitney U test was run to determine if there were differences in the quality of jobs created score between companies that did and did not benefit from SIFIDE in the last five years. Distributions of the quality of jobs created (07EXPEREMP) scores for companies that did and did not benefit from SIFIDE in the last five years were not similar, as assessed by visual inspection. The quality of jobs created (07EXPEREMP) scores for companies that did benefit from SIFIDE in the last five years (mean rank = 145.89) were statistically significantly higher than for those who did not (mean rank = 55.11), $U = 461.000$, $z = -11.091$, $p < .001$. Median quality of jobs created (07EXPEREMP) score was statistically significantly higher for companies that did benefit from SIFIDE in the last five years (24.752) than for those who did not (13.340).

A Mann-Whitney U test was run to determine if there were differences in the value added per employee score between companies that did and did not benefit from SIFIDE in the last five years. Distributions of the value added per employee (08VAPEREMP) scores for companies that did and did not benefit from SIFIDE in the last five years were not similar, as assessed by visual inspection. The value added per employee (08VAPEREMP) scores for companies that did benefit from SIFIDE in the last five years (mean rank = 147.25) were statistically significantly higher than for those who did not (mean rank = 53.74), $U = 461.000$, $z = -11.423$, $p < .001$. Median value added per employee (08VAPEREMP) score was statistically significantly higher for companies that did benefit from SIFIDE in the last five years (35.027) than for those who did not (18.068).

A Mann-Whitney U test was run to determine if there were differences in the openness of the companies to external markets score between companies that did and did not benefit from SIFIDE in the last five years. Distributions of the openness of the companies to external markets (09EXPORTURN) scores for companies that did and did not benefit from SIFIDE in the last five years were not similar, as assessed by visual inspection. The openness of the companies to external markets (09EXPORTURN) scores for companies that did benefit from

SIFIDE in the last five years (mean rank = 138.89) were statistically significantly higher than for those who did not (mean rank = 62.11), $U = 1161.000$, $z = -9.966$, $p < .001$. Median openness of the companies to external markets (09EXPORTURN) score was statistically significantly higher for companies that did benefit from SIFIDE in the last five years (0.260) than for those who did not (0.000).

Discussion

Considering the results presented previously and the null hypothesis framed initially (H_0 : The two groups of companies, defined by the way they use R&D tax credits, have the same competitiveness performance indicators), although it is not possible to categorically reject it, it is possible to verify that the companies that benefited from tax incentives present a clearly distinct behavior from the companies that did not, not only in what regards the mix they make with the grants available (05GRANTS) but also in what regards financial performance (01COMPER and 02PROFIT). Furthermore, they present a clearly distinctive behavior in what regards the importance that the intangible assets present when weighted against the total assets of the company (04PRODINTA) or in what regards the quality (07EXPEREMP) and value-added (08VAPEREMP) of the jobs created, with companies clearly aiming at external markets (09EXPORTURN).

Framing the results obtained against the literature review performed earlier, it is clear that most companies that use the R&D tax incentives, also use the grants provided by the European, national and regional funding mechanisms. Also, the companies that benefit from SIFIDE show a better performance in what regards the ratio between the total yearly expenditure on salaries and the number of employees, presenting evidence that SIFIDE beneficiary companies have better paying jobs, thus retaining talented people in order to perform non-routine, value added work. Although the results are clearly favorable in what relates to the results shown by the SIFIDE beneficiaries, it must be stressed that the values relate to the median obtained as a result of the application of the Mann Whitney U test and not the mean values that could be obtained if the normality test had been successful and the one-way ANOVA test. Also, and since we are dealing with public policies that usually lack the technical expertise in the evaluation of the R&D investments, rather relying on the financial demonstration of the investments made, there can be a bias in the results shown by the SIFIDE beneficiary companies, thus resulting in a “the need to show” effect propelled by the need to demonstrate the financial results of the investments made.

As a final note for future research, and since there are multiple R&D tax credit schemes in OECD, probably a comparison between the effectiveness of the schemes could be performed, based on the results that the beneficiary start-up companies in each country present in their financial results.

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Derramas Tecnológicas Inversas y Desempeño Innovador: El Caso de las Empresas Transnacionales Mexicanas, 1994-2015

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Abstract: The expansion of transnational corporations from emerging economies during the last decades has generated a great interest among scholars in analyzing the presence of reverse technology spillovers. This kind of spillovers are generated when transnational corporations use outward FDI to attract and transfer knowledge and technology from abroad to improve their own technology capabilities in their home countries. The aim of this research is to analyze the presence and impact of reverse technology spillovers on Mexican transnational firm performance innovation. Using panel data *Tobit* econometric models of 13 Mexican multinational corporations over the period of 1994-2015, results confirm the presence of reverse technology spillovers that could be attracted through Mexican firms' absorptive capabilities. The paper concludes discussing the need of implementing adequate public policies to support the internationalization of the Mexican multinational corporations.

Keywords: reverse technology spillovers; absorptive capacity; foreign direct investment; multinational corporations; Mexico; *Tobit* econometric models

Resumen: La expansión de las empresas transnacionales de los países emergentes durante las últimas décadas ha generado un interés creciente entre los académicos por analizar las derramas tecnológicas inversas. Estas derramas se generan cuando las empresas transnacionales utilizan sus inversiones en países receptores más avanzados con el fin de transferir y absorber tecnologías y conocimientos, mejorando de esta forma sus propias capacidades tecnológicas. El objetivo de este trabajo es analizar la presencia y el impacto que pueden tener las derramas tecnológicas inversas en el desempeño innovador de las empresas transnacionales mexicanas. A través de modelos econométricos *Tobit* de datos panel para 13 empresas transnacionales mexicanas y con información para el período 1994-2015, los resultados aportan evidencia de la existencia de derramas tecnológicas inversas que pueden ser apropiadas a través de la capacidad de absorción de estas empresas. El trabajo concluye discutiendo la necesidad de implementar políticas públicas adecuadas que incentiven la internacionalización de las empresas mexicanas.

Palabras clave: derramas tecnológicas inversas; capacidad de absorción; inversión extranjera directa; empresas transnacionales; México; modelos econométricos *Tobit*

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1. Introducción

La presencia y los efectos que tiene la inversión extranjera directa (IED) en los países receptores, comenzó a ser un tema de gran interés en las agendas de los investigadores de las universidades durante la década de los años noventa. Durante esos años, diversos factores contribuyeron de manera significativa a impulsar el estudio de la IED en numerosos países y regiones del mundo, entre los que destacan (Govindarajan y Ramamurti, 2011; Rugman, 2009): (i) el papel que venían jugando las empresas transnacionales (ETN) en los procesos de transferencia de recursos financieros, (ii) la implementación de políticas económicas por parte de muchos gobiernos inspiradas en una visión más abierta de la economía mundial, (iii) la inclusión de algunos países como China en la Organización Mundial del Comercio (OMC) y (iv) una mayor integración regional de muchas economías a través de la firma de tratados y acuerdos comerciales. En el caso de las economías emergentes, los flujos de IED a través de sus ETN les permitió convertirse en inversoras netas en algunos mercados más desarrollados (Buckley et al., 2010; Deng, 2009). En este sentido, por ejemplo, el monto de IED proveniente de las economías

emergentes representó el 10% de la IED total a nivel mundial durante el año 2000 y 30.6% en el año 2013, lo que se tradujo en un flujo de recursos de más de 426 miles de millones de dólares en este último año (UNCTAD, 2015).

Algunos de los estudios que han analizado el comportamiento de la IED proveniente de las economías emergentes han identificado la posibilidad de absorber y transferir conocimientos y capacidades tecnológicas disponibles en las economías industrializadas a las plantas matrices de las empresas en esas economías (Amann y Virmani, 2015; Buckley et al., 2010; Chen et al., 2012; Deng, 2009; Mathews y Zander, 2007). En el caso particular de México, la generación de condiciones adecuadas a través de la apertura comercial y la atracción de una mayor cantidad de IED ha sido una prioridad con el fin de estimular la actividad económica, la generación de empleos y la apropiabilidad de nuevos conocimientos y tecnologías desde el exterior (Armas y Rodríguez, 2017; Kunhardt, 2013; Vargas-Hernández y Noruzi, 2010). Sin embargo, la IED de las empresas transnacionales mexicanas (ET-NMX) había sido de poco interés para los académicos en las universidades hasta que las operaciones de estas empresas comenzaron a tener

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una participación mayoritaria en muchos mercados de las economías más desarrolladas. Dentro de la lista anual de compañías globales que publica la revista *Forbes*, por ejemplo, destacaban 15 ETNMX en el año 2000, entre las que se encontraban Grupo Bimbo, America Movil y CEMEX (Forbes, 2015). Otros estudios similares muestran que entre 1999 y 2002, CEMEX, America Movil, Grupo Bimbo, Gruma, Savia, Grupo Imsa y Cintra se encontraban entre las 50 multinacionales más importantes provenientes de América Latina (Vargas-Hernández y Noruzi, 2010). Se podría decir entonces que la expansión internacional de las ETNMX da cuenta de su madurez en los mercados, permitiéndoles de esta forma competir exitosamente con otras empresas provenientes de las economías más avanzadas.

Uno de los hallazgos más importantes de los primeros estudios que han buscado explicar la internacionalización de las ETN provenientes de las economías emergentes fue que los mismos factores que durante mucho tiempo impidieron la expansión de estas empresas, se convirtieron posteriormente en una de sus mayores ventajas competitivas (Cuervo-Cazurra, 2011; Gammeltoft et al., 2010). En el caso particular de México, factores tales como (i) la desregulación de sus mercados durante los años noventa, (ii) la desprotección por parte del Estado de muchas de sus empresas, (iii) la disponibilidad de capacidades y talento ejecutivo, (iv) el posicionamiento exitoso de muchas marcas mexicanas y (v) el acceso a tecnologías de punta, entre otros, han contribuido a la expansión de las ETNMX (Khana y Palepu, 2006). En este mismo sentido, con la entrada en vigor del Tratado de Libre Comercio de América del Norte (TLCAN) en 1994, se abrieron los mercados de Estados Unidos y Canadá a los bienes y servicios mexicanos, forzando de esta forma a las ETNMX a desarrollar estrategias competitivas de crecimiento más allá de sus fronteras (Armas y Rodríguez, 2017; Rodríguez et al., 2015).

El caso de México es muy ilustrativo de la incursión de ETN en otros mercados extranjeros, ya que desde el año 2001 su monto de inversión en el extranjero ha crecido significativamente de tal forma que para el año 2012, sus flujos de IED hacia otros países (*outward FDI*) logró superar los montos de IED hacia México (*inward FDI*) (UNCTAD, 2015). La literatura especializada en este tema señala que la lógica de este comportamiento radica en el interés que tienen numerosas ETN de los países emergentes en buscar y asimilar nuevos conocimientos y tecnologías una vez que inician operaciones en los países receptores más desarrollados (Child y Rodrigues, 2005; Mathews, 2002; Luo y Tung, 2007). Podría decirse entonces que un mayor monto de inversiones proveniente de las economías emergentes ha permitido a sus ETN destinar una mayor cantidad de recursos para actividades de investigación y desarrollo (I+D) y, de esta forma, desarrollar un número mayor de innovaciones (Li et al., 2010; Govindarajan y Ramamurti, 2011). La evidencia empírica ha demostrado que, en contraste con la transferencia tecnológica directa que permite la IED, la presencia de derramas tecnológicas inversas (*reverse technology spillovers*) depende de la capacidad de absorción que tienen las ETN provenientes de las economías emergentes, así como de las tecnologías ya existentes en los países en donde se instalan estas empresas (Cohen y Levinthal, 1990; Fu et al., 2010). Las derramas tecnológicas inversas se pueden definir entonces como “la medida en que las ETN originarias de países

emergentes utilizan la IED en un país industrializado a través de ciertos mecanismos que les permiten absorber y transferir el conocimiento, mejorando de esta forma sus capacidades tecnológicas en sus países de origen” (Chen et al., 2012).

Por otra parte, ya que la generación de innovaciones es un factor de crecimiento y desarrollo económico para un país (Griliches, 1986; Nelson, 1993; Schumpeter, 1939), resultaría interesante investigar el desempeño innovador y su posible impacto en el desarrollo económico de las economías emergentes. En el caso particular de México, el potencial de crecimiento de las ETNMX a través de sus subsidiarias e inversiones en el extranjero trasciende la búsqueda simple de utilidades y se extiende al ámbito del acceso a nuevas tecnologías. Este hecho abre la posibilidad de que las ETNMX transfieran eventualmente dichas tecnologías al resto de la economía nacional, contribuyendo de esta forma a ampliar la base tecnológica en este país para alcanzar un mayor desarrollo innovador (Gammeltoft y Hobdari, 2017).

El objetivo de esta investigación es doble. En primer término, este trabajo busca identificar para el caso de México la existencia de transferencias tecnológicas que se generen a partir de derramas tecnológicas inversas. En segundo término, esta investigación busca medir el impacto que puedan tener estas derramas tecnológicas inversas en la capacidad innovadora de las propias ETNMX. De esta forma, a partir de estos objetivos, se pueden establecer las siguientes preguntas de investigación. Primero, ¿la IED que realizan las ETNMX en otros países (v.g. economías industrializadas) les ha permitido tener acceso a cierto tipo de derramas tecnológicas inversas? Segundo, ¿cuál es el impacto que han tenido estas derramas tecnológicas inversas en el desempeño innovador de las ETNMX? Las respuestas a estas preguntas deberán obtenerse de manera simultánea. El período de análisis es de 1994 a 2015.

Además de esta introducción, este trabajo se organiza en cuatro secciones. La sección 2 hace una breve revisión de literatura en relación con la IED y las derramas tecnológicas inversas. La sección 3 discute tres modelos econométricos propuestos para buscar la existencia y el impacto que pueden tener las derramas tecnológicas inversas en la capacidad innovadora de las ETNMX. La sección 4 analiza los resultados obtenidos a partir de los modelos econométricos desarrollados en este trabajo. Finalmente, la sección 5 presenta las conclusiones más importantes de esta investigación.

2. Revisión de literatura

2.1 Inversión extranjera directa y transferencia de tecnología

En la literatura que analiza el papel que juega la IED en el desarrollo económico de un país, existe una corriente teórica que discute el aprovechamiento de las tecnologías que se generan fuera de las fronteras de una nación (Blomström et al., 2001). Dentro de esta corriente teórica se encuentra el *paradigma ecléctico* que enfatiza la relación que existe entre inversión en desarrollo tecnológico y generación de patentes (Anand y Kogut, 1997; Cantwell, 1989; Dunning, 1977). Este paradigma busca explicar las diferencias que existen entre las

capacidades tecnológicas de las empresas dentro de una misma industria, por un lado, y las diferencias que existen en la actividad patentadora de las empresas de una industria y entre industrias, por el otro (Anand y Kogut, 1997). Estas diferencias tecnológicas entre empresas dentro de una misma industria frecuentemente son el resultado de un proceso histórico de acumulación de recursos y capacidades (Nelson y Winter, 1982). Desde esta perspectiva, se podrían identificar dos características importantes que explican el comportamiento de la IED en los países receptores. Primero, se podría decir que la IED se concentra en los sectores en los que el país receptor posea un mayor nivel de avance tecnológico (Anand y Kogut, 1997). Segundo, muchas veces se argumenta que la IED (*inward FDI*) en un país se relaciona de manera positiva con un mercado atractivo medido a través de su tamaño, crecimiento y grado de competencia (Anand y Kogut, 1997).

Por otro lado, existen otro tipo de explicaciones sobre el comportamiento de la IED proveniente de las economías emergentes y que se basan en “*la motivación por la búsqueda de conocimiento*” (Chen et al., 2012). Este enfoque enfatiza que la internacionalización de las ETN proveniente de esas economías juega un papel de “trampolín” para acceder al conocimiento que se genera en las economías más avanzadas, compensando de esta forma su debilidad competitiva y la calidad de “*recién llegado*” a los países receptores (Chen et al., 2012; Child y Rodrigues, 2005; Luo y Tung, 2007; Makino et al., 2002, 2006; Mathews y Zander, 2007). Desde esta perspectiva, el objetivo fundamental de la IED proveniente de las economías emergentes sería la exploración y penetración de los mercados en las economías más desarrolladas a fin de que las ETN provenientes de las economías emergentes puedan mejorar sus propias capacidades tecnológicas (Govindarajan y Ramamurti, 2011).

En consecuencia, es posible encontrar en la literatura tres explicaciones teóricas alternativas sobre el comportamiento de la IED proveniente de las economías emergentes. La primera corriente de literatura sugiere que las ETN provenientes de las economías emergentes buscan reducir su dependencia tecnológica desarrollando ellas mismas sus propios conocimientos e innovaciones (Fu et al., 2010). Una segunda explicación sobre el comportamiento de la IED proveniente de las economías emergentes sugiere que los gobiernos de estos países buscan a menudo alentar y recompensar los esfuerzos por generar tecnologías propias a partir de implementar políticas favorables para alcanzar este objetivo (v.g. incentivos fiscales, asistencia financiera, etc.) (Peng, 2010). Finalmente, una tercera explicación sobre el comportamiento de la IED proveniente de las economías emergentes sugiere que la mayoría de las ETN provenientes de estos países carecen de capacidades propias para coordinar actividades de I+D y, por lo tanto, éstas sólo se concentran en desarrollar tecnologías competitivas a nivel nacional (Luo y Tung, 2007; Wei, 2010). Es importante no poder de vista que este tercer bloque de literatura sobre el comportamiento de las ETN provenientes de los países emergentes sugiere que sus empresas no poseen los conocimientos y las capacidades necesarios para emprender actividades de I+D, proponiendo entonces que el acceso a nuevas tecnologías provenientes del extranjero es crucial para que estas empresas mejoren sus propias capacidades tecnológicas e innovadoras (Li et al., 2010).

2.2 Transferencia de tecnología y derramas tecnológicas inversas

Entre los primeros trabajos en la literatura especializada que analizan las derramas tecnológicas inversas destaca el estudio de Kogut y Chang (1991) quienes identificaron la existencia de estas derramas – aunque no se refieren a ellas como tales – a través de los efectos provenientes de las capacidades tecnológicas generadas por la IED japonesa en 297 industrias de los Estados Unidos. Estos autores encontraron que existe una alta concentración en las industrias intensivas en IED, señalando que las firmas japonesas habían incursionado en los mercados de los estadounidenses con capacidades tecnológicas más fuertes a costa de un mayor gasto en I+D que en Japón (Kogut y Chang, 1991). En este mismo sentido, Kuemmerle (1999) encontró que las empresas multinacionales tienden a establecer laboratorios para realizar actividades de I+D en el mercado receptor cuando en este país se realizan más actividades de este tipo y ofrece una mayor cantidad de recursos humanos calificados que en el país de origen. Por su parte, van Pottelsberghe de la Potterie y Lichtenberg (2001) realizaron un estudio sobre la inversión japonesa en los Estados Unidos, identificando algunos procesos de transferencia de tecnología concluyendo que la mayor transferencia de tecnología se da desde Estados Unidos hacia Japón.

Makino et al. (2002) por su parte establecieron algunas hipótesis en relación con las decisiones estratégicas de las ETN para la localización de la IED proveniente de algunas economías de reciente industrialización. Usando una muestra de 328 empresas taiwanesas, este autor encontró que las motivaciones de las ETN provenientes de los países emergentes tienen un impacto significativo en la elección de localización de sus inversiones entre los países más desarrollados o los menos desarrollados (Makino et al., 2002). Adicionalmente, este estudio también calculó el impacto que puede tener la IED en el desarrollo de las capacidades tecnológicas de las ETN provenientes de las economías emergentes (Makino et al., 2002). Estos resultados encontraron que aspectos como la explotación de activos, así como la búsqueda de otros activos (nuevas tecnologías) predicen la localización de las inversiones que realizan las empresas de los países de reciente industrialización (Makino et al., 2002).

El estudio de Driffield y Love (2003) aborda la presencia de derramas tecnológicas inversas en el Reino Unido de acuerdo con la motivación de las ETN por acceder a tecnologías superiores que las existentes en sus países de origen. Este argumento implica la existencia de externalidades tecnológicas en el país receptor de esas inversiones (Driffield y Love, 2003). El estudio de estos autores probó la presencia de este tipo de derramas, pero únicamente en los sectores intensivos en I+D (Driffield y Love, 2003). Por su parte, Child y Rodrigues (2005) analizaron los patrones y motivos para la internacionalización de las empresas chinas que buscan expandir su presencia en los mercados internacionales. Estos autores, a través de estudios de caso, demostraron que estas empresas que buscan activos de alta tecnología para establecer una posición competitiva en los mercados internacionales comprometían sus inversiones con una internacionalización “*interna*” por medio de la fabricación de equipos originales y asociaciones tipo *joint ventures*, así como también una internacionalización “*externa*” a través de la adquisición y crecimiento en el extranjero (Child y Rodrigues, 2005).

El trabajo de Wei (2010) sugiere que el contexto en donde se genera el conocimiento local contribuye a incrementar la productividad de las ETN, mostrando evidencia de la existencia de derramas tecnológicas inversas mutuas entre las empresas chinas y las empresas extranjeras. En este mismo sentido, Yang et al. (2011), a través de un modelo de datos panel y analizando la capacidad de absorción a nivel provincial para el período 2003-2008, hicieron una medición de las derramas tecnológicas inversas que se generan a través de la IED originada en China. Los hallazgos principales de estos autores sugirieron que la disponibilidad de capital humano potencializa de manera significativa la productividad total de los factores, pero con un impacto poco significativo en la capacidad de absorción (Yang et al., 2011). El trabajo concluye señalando que es esencial incrementar la inversión en educación a través de políticas educativas que formen parte de la estrategia de internacionalización de la IED (*outward FDI*) de China (Yang et al., 2011).

Los trabajos de Chen (2010) y Chen et al., (2012) son los primeros en abordar el tema de las derramas tecnológicas inversas como tales. Chen (2010) y Chen et al., (2012) abordan la posibilidad de que la IED que realizan las ETN de los países emergentes sean capaces de absorber conocimientos y tecnologías proveniente del exterior. Estos autores encontraron evidencia suficiente a favor de la presencia de derramas tecnológicas inversas y del proceso de internacionalización de las ETN provenientes de los países emergentes. Estos autores realizaron su análisis en tres etapas (Chen, 2010): (i) la primera etapa se denomina “*salida*” y analiza el papel heterogéneo que juegan las instituciones subnacionales (v.g. empresas) en la toma de decisiones para invertir en el extranjero, (ii) la segunda etapa se denomina “*entrada*” y su análisis incorpora elementos de la teoría de los costos de transacción (Williamson, 1971, 1979) y estudia los efectos de esta heterogeneidad a nivel subnacional en la toma de decisiones y sobre la forma en que se adquieren las empresas extranjeras (v.g. fusiones, adquisiciones, etc.) y (iii) la tercera etapa se denominada “*regreso*” y analiza de forma más precisa la existencia de derramas tecnológicas inversas y cómo las ETN las absorben para su aprovechamiento.

En síntesis, la aparición de derramas tecnológicas inversas sólo es posible en la medida en que las ETN provenientes de los países emergentes puedan financiar el costo de acceder a nuevas tecnologías, recursos productivos y acceso a nuevos mercados en las economías más avanzadas (Dunning y Lundan, 2008). Es importante mencionar que este tipo de derramas tecnológicas sólo se pueden dar cuando las ETN de las economías emergentes implementan alguna de las siguientes decisiones estratégicas (Dunning y Lundan, 2008):

1. Estableciendo vínculos con las empresas de las economías tecnológicamente más desarrolladas.
2. Incrementando su capacidad de absorción que les permita aprovechar los conocimientos y las tecnologías que se encuentran libres en los países tecnológicamente más avanzados.
3. Teniendo acceso a conocimientos estratégicos en relación con las condiciones en que operan los mercados de los países más avanzados.
4. Implementando nuevos métodos de producción y abastecimiento.

De esta forma, el conocimiento y las tecnologías de los países tecnológicamente más avanzados pueden transferirse hacia las subsidiarias de las ETN de los países emergentes a través de alguno de los siguientes mecanismos (Chen, 2010; Chen et al., 2012):

1. A través de la participación de las ETN de los países emergentes en las cadenas locales de suministro (Javorcik, 2004).
2. Teniendo acceso y asimilando las tecnologías y el *know-how* de las economías más avanzadas interactuando con sus líderes tecnológicos e innovadores (v.g. científicos, ingenieros, etc.) (Almeida y Kogut, 1999).
3. Contratando personal con experiencia y capacidades en áreas empresariales y/o gubernamentales que puedan gestionar y desarrollar actividades de I+D (Møen, 2007).

En la siguiente sección se discute los modelos econométricos desarrollados en esta investigación con el fin de probar la existencia de derramas tecnológicas inversas y su aprovechamiento por parte de las ETNMX.

3. Fuentes de información y modelos econométricos

3.1 Fuentes de información y muestra

En este trabajo, la medición de las derramas tecnológicas inversas se basa en la metodología propuesta por Chen (2010) y Chen et al., (2012). Los modelos econométricos que se desarrollan utilizan una muestra de 13 ETNMX seleccionadas bajo los siguientes criterios: (i) cantidad de activos en el extranjero, (ii) número de subsidiarias en el extranjero, (iii) intensidad en actividades de I+D y (iv) disponibilidad de información. Estos criterios de selección son los mismos que se utilizan en el primer estudio de seguimiento sobre el desempeño de las empresas transnacionales mexicanas conocido como *Emerging Market Global Players* y patrocinado por la Universidad Nacional Autónoma de México y Vale Columbia Center for Sustainable International Investment (Sauvant et al., 2011).

Particularmente, para efectos de esta investigación, se seleccionó inicialmente una muestra de 20 ETNMX. La disponibilidad de datos redujo la muestra a solamente 13 ETNMX con información para el período 1994 a 2015. Esta selección permitió contar con un panel de datos de 286 observaciones. Los datos se extrajeron a partir de los estados financieros trimestrales y anuales publicados por las propias empresas en sus páginas de Internet, así como también de los informes anuales emitidos por la Bolsa Mexicana de Valores (BMV). La información a nivel de industria se obtuvo del Sistema de Información de la Gaceta de la Propiedad Industrial del Instituto Mexicano de la Propiedad Industrial (IMPI), de las bases de datos de la Organización para la Cooperación y el Desarrollo Económico (OCDE), de la Organización Mundial de la Propiedad Intelectual (OMPI) y del Instituto Nacional Estadística y Geografía (INEGI).

3.2 Modelos econométricos

3.2.1 Variable dependiente

La variable dependiente en esta investigación es el *Desempeño Innovador* (DINN) de las ETNMX. Esta variable se construyó a partir del número de procesos de innovación desarrollados por cada empresa, así como por los montos de inversión que cada empresa realizó para desarrollar actividades de I+D. El conteo de los procesos de innovación por áreas y departamentos de las empresas dentro de la muestra se hizo siguiendo la metodología utilizada en algunos de los trabajos discutidos en la sección anterior (Chen, 2010; Chen et al., 2012), además también se incluyó el número de patentes otorgadas y solicitadas con el fin de desarrollar un indicador más robusto del desempeño innovador de estas empresas. Por su parte, para medir el monto del gasto en I+D, se consideró la capacidad tecnológica de las empresas que refleja su habilidad para absorber y utilizar los conocimientos externos transferidos por las subsidiarias de ETNMX. Este proceso permitió de esta forma capturar las derramas tecnológicas inversas (Chen, 2010; Chen et al., 2012; Baysinger y Hoskisson, 1989; Hundley et al., 1996). Finalmente, las variables independientes se definieron a partir de tres niveles de análisis: (i) abastecimiento tecnológico, (ii) capacidad de absorción y (iii) variables de control. Este enfoque en el uso de las variables independientes permitió definir tres modelos econométricos diferentes y con el fin de probar las hipótesis establecidas en esta investigación.

3.2.2 Modelo de abastecimiento tecnológico

El primero grupo de variables independientes constituyen el modelo de abastecimiento tecnológico a nivel industria-país y que mide la motivación por el abastecimiento tecnológico por parte de las ETNMX en los mercados internacionales. Las variables independientes en este modelo explican la actividad innovadora de las ETNMX en los países receptores de IED en los siguientes términos. Primero, la variable independiente *Empleo en Actividades en I+D* (RHID) de las ETNMX en los países receptores se definió a partir de la cantidad de recursos humanos dedicados a actividades en I+D en los países hacia donde se dirige la IED que realizan las ETNMX. La variable RHID se rezagó un período de tiempo, ya que la dotación de recursos humanos tarda en desarrollar sus habilidades y conocimientos especializados necesarios para realizar actividades de I+D (Song et al., 2003). Segundo, la variable independiente *Gasto en Actividades en I+D* (GID) de las ETNMX en los países receptores se definió por la cantidad de gastos realizados por las ETNMX en dólares de los Estados Unidos en los países receptores (v.g. salarios para investigadores, inversión en infraestructura tecnológica, entre otros). Esta variable también se rezagó un período de tiempo, ya que refleja los esfuerzos de las ETNMX por generar innovaciones para competir en los mercados internacionales en donde éstas se establecen (Glass y Saggi, 1988; Keller, 1996; Kim y Dahlman, 1992; Veugelers, 1997; Gornik y Millan, 2005). Finalmente, la variable independiente *Número de Solicitudes de Patentes* (PAT) de las ETNMX en los países receptores incluyó el número de solicitudes de patentes de residentes y no residentes que realizaron las ETNMX en las economías receptoras (Chen, 2012;

Zhou y Li, 2008). De esta forma, fue posible establecer las hipótesis 1a – 1c que muestran la relación existente entre DINN y las variables independientes del modelo de abastecimiento tecnológico:

Hipótesis 1a: La cantidad de recursos dedicados al empleo de trabajadores en actividades de investigación y desarrollo por parte de las empresas subsidiarias de las empresas transnacionales mexicanas en los países receptores, tiene un impacto positivo en el desempeño innovador de las empresas transnacionales mexicanas ($a_1 > 0$).

Hipótesis 1b: La cantidad de recursos dedicados a actividades de investigación y desarrollo que realizan las empresas subsidiarias de las empresas transnacionales mexicanas en los países receptores, tiene un impacto positivo en el desempeño innovador de las empresas transnacionales mexicanas ($a_2 > 0$).

Hipótesis 1c: El número de solicitudes de patentes que realizan las empresas subsidiarias de las empresas transnacionales mexicanas en los países receptores, tiene un impacto positivo en el desempeño innovador de las empresas transnacionales mexicanas ($a_3 > 0$).

La ecuación 1 muestra la relación que existe entre las variables independientes del modelo de abastecimiento tecnológico y DINN de las ETNMX:

$$DINN = CONST + \alpha_1 RHID_{-1} + \alpha_2 GID_{-1} + \alpha_3 PAT_{-1} + \varepsilon_{it} \quad (1)$$

3.2.3 Modelo de capacidad de absorción

El segundo grupo de variables independientes permite medir la capacidad de absorción de las ETNMX. La variable independiente *Activos Totales* (ACT) de las ETNMX se definió en dólares de los Estados Unidos. La inclusión de esta variable se justificó por el hecho de que las empresas más grandes estarán mayormente dispuestas a llevar a cabo un monto mayor de inversiones, incluyendo aquellas que permiten mayores desarrollos tecnológicos (Cohen et al., 1987; Geroski, 1990; Kraft, 1989; Acs y Audretsch, 1988; Henderson y Cockburn, 1996; Shefer y Frankel, 2005). La segunda variable independiente que se incluyó en el modelo de capacidad de absorción fue la *Edad en el Mercado* (ED) de las ETNMX medida por el logaritmo del número de años que tenía cada una de estas empresas desde su fundación y hasta el año 2015. La inclusión de esta variable se justificó por el hecho de que las empresas más jóvenes suelen tener una menor inercia y se comprometen más con la posibilidad de desarrollar innovaciones (Balasubramanian y Lee, 2008). La tercera variable independiente que se incluyó en el modelo de capacidad de absorción fue el *Coefficiente de Liquidez* (LIQ) de las ETNMX medida como el coeficiente entre los activos corrientes y los pasivos exigibles. Esta variable mide la presión de solvencia a corto plazo que tienen las ETNMX, respaldada por el hecho de que las empresas son altamente sensibles a una “presión financiera” (Hall y Mansfield, 1971; Ozkan, 2002). Finalmente, la cuarta variable independiente en este modelo fue el *Coefficiente de Solvencia* (SOLV) calculado a partir del coeficiente de activos totales con respecto a los pasivos exigibles (Chen et al., 2012). Esta variable mide

la presión de solvencia de las ETNMX en el largo plazo. De esta forma fue posible establecer las hipótesis 2a – 2d que muestran la relación existente entre DINN y las variables independientes del modelo de capacidad de absorción:

Hipótesis 2a. El tamaño de las empresas transnacionales mexicanas tiene un impacto positivo en el desempeño innovador de estas empresas ($a_4 > 0$).

Hipótesis 2b. La edad de las empresas transnacionales mexicanas tiene un impacto negativo en el desempeño innovador de estas empresas ($a_5 > 0$).

Hipótesis 2c. El coeficiente de liquidez de las empresas transnacionales mexicanas tiene un impacto positivo en el desempeño innovador de estas empresas ($a_6 > 0$).

Hipótesis 2d. El coeficiente de solvencia de las empresas transnacionales mexicanas tiene un impacto positivo en el desempeño innovador de estas empresas ($a_7 > 0$).

La ecuación 2 muestra la relación que existe entre las variables independientes del modelo de capacidad de absorción y DINN de las ETNMX:

$$DINN = CONST + \alpha_4 ACT + \alpha_5 ED + \alpha_6 LIQ + \alpha_7 SOLV + \varepsilon_{it} \quad (2)$$

3.2.4 Variables de control

El tercer grupo de variables independientes constituyen el modelo con variables de control. Estas variables captan los contextos económicos específicos de México y de los países receptores de IED de las ETNMX. La primera variable independiente en este modelo fue *Actividades de I+D* (IDMX) en México que se calculó como el logaritmo del gasto total en I+D a nivel industria durante un periodo de un año. La inclusión de esta variable se justificó por el hecho de que el nivel total de gastos en I+D se ve afectado por los recursos tecnológicos disponibles en el país de origen (Branstetter, 2001). La segunda variable independiente en este modelo fue el *Tamaño del Mercado Mexicano* (PIBMX) y se midió como el logaritmo del Producto Interno Bruto de México a precios constantes (Bergstrand, 1985). La tercera variable independiente en el modelo con variables de control fue la *Carga Impositiva en México* (IMPMX) medida por la tasa efectiva de recaudación y es un factor institucional que puede afectar los fondos disponibles para I+D (Hall, 1993). Finalmente, la cuarta variable independiente en el modelo con variables de control fue el *Tamaño del Mercado de los Países Receptores* (PIBR) que se calculó por el logaritmo del Producto Interno Bruto de los países receptores a precios constantes (Bergstrand, 1985). De esta forma fue posible establecer las hipótesis 3a – 3d que muestran la relación existente entre DINN y las variables independientes del modelo con variables de control:

Hipótesis 3a: Las actividades de investigación y desarrollo en México tienen un impacto positivo en el desempeño innovador de las empresas transnacionales mexicanas ($a_8 > 0$).

Hipótesis 3b: El Producto Interno Bruto real de México tiene un impacto positivo en el desempeño innovador de las empresas transnacionales mexicanas ($a_9 > 0$).

Hipótesis 3c: La carga impositiva en México tiene un impacto negativo en el desempeño innovador de las empresas transnacionales mexicanas ($a_{10} > 0$).

Hipótesis 3d: El Producto Interno Bruto real de los países receptores tiene un impacto positivo en el desempeño innovador de las empresas transnacionales mexicanas ($a_{11} > 0$).

La ecuación 3 muestra la relación existente entre las variables independientes del modelo con variables de control y DINN de las ETNMX:

$$DINN = CONST + \alpha_8 IDMX + \alpha_9 PIBMX + \alpha_{10} IMPMX + \alpha_{11} PIBR + \varepsilon_{it} \quad (3)$$

En síntesis, el modelo de abastecimiento tecnológico (hipótesis 1a – 1c) busca probar la existencia de derramas tecnológicas inversas en los mercados en donde se establecen las empresas subsidiarias de las ETNMX. Este modelo contribuye a contestar la primera pregunta planteada en esta investigación. Por su parte, el modelo de capacidad de absorción (hipótesis 2a – 2d) busca medir el impacto que pueden tener las derramas tecnológicas inversas en DINN de las ETNMX. Este modelo contribuye a contestar la segunda pregunta planteada en esta investigación. Finalmente, el modelo con variables de control (hipótesis 3a – 3d) busca captar los efectos que pudieran los contextos económicos de México y de los países receptores sobre DINN. El cuadro 1 resume las variables independientes y los signos esperados en cada uno de los tres modelos econométricos probados en esta investigación.

Cuadro 1. Desempeño innovador de las empresas transnacionales mexicanas

Modelo	Variable	Signo Esperado
Abastecimiento Tecnológico	i. RHID (empleo en actividades en I+D en el país receptor)	+
	ii. GID (gasto en actividades en I+D en el país receptor)	+
	iii. PAT (solicitudes de patentes en el país receptor)	+
Capacidad de Absorción	iv. ACT (tamaño de las ETNMX)	+
	v. ED (edad de las ETNMX)	-
	vi. LIQ (coeficiente de liquidez de las ETNMX)	+
	vii. SOLV (coeficiente de solvencia de las ETNMX)	+
Variables de Control	viii. IDMX (gasto en actividades en I+D en México)	+
	ix. PIBMX (PIB a precios constantes de México)	+
	x. IMPMX (carga impositiva en México)	-
	xi. PIBR (PIB a precios constantes del país receptor)	+

En la siguiente sección se discute el proceso de estimación de los modelos econométricos que se presentan en esta investigación para probar empíricamente las hipótesis propuestas y con el fin de responder las preguntas de investigación presentadas en la introducción de este trabajo.

3.3 Estimación de los modelos econométricos

Para probar empíricamente las hipótesis de la sección anterior, se estimaron tres modelos econométricos *Tobit* (Tobin, 1958) que son una extensión de los modelos econométricos *Probit*. Es importante mencionar que este tipo de modelos ya se han aplicado en otros estudios empíricos caracterizados por contener una variable dependiente censurada (Chen et al., 2012). Esto quiere decir que, si en una muestra la información sobre la variable dependiente está disponible sólo para algunas observaciones, se dice entonces que esta muestra está censurada (Gujarati y Porter, 2009). La estimación de los modelos *Tobit* se realiza mediante el método de máxima verosimilitud que consiste en encontrar los valores de los parámetros que maximizan la probabilidad de obtener la muestra observada (Fisher, 1921). De esta forma, un modelo de esta naturaleza se puede definir por la siguiente expresión (Greene, 1999):

$$Y_i = \beta'x_i + e_i \quad (4)$$

En donde β es el vector de parámetros a estimar y e_i es el vector de variables independientes del modelo. Los modelos *Tobit* permiten distinguir dos tipos de efectos ante cambios en las variables independientes, ya que un cambio en e_i puede afectar a la media condicionada de Y_i (en el lado positivo de la distribución). Específicamente, esto significa para esta investigación que la intensidad del nivel de innovaciones afecta a la probabilidad de que las observaciones se encuentren en esa parte de la distribución (la probabilidad de realizar innovaciones).

El análisis econométrico de los modelos *Tobit* se puede realizar a través de un modelo de datos panel estimado con estadísticos *pooled* y a través de una estimación por efectos aleatorios (Wooldridge, 2002). El primero no toma en cuenta que las empresas son las mismas de unos años a otros (considera a todas las observaciones como individuos distintos), mientras que el estimador de efectos aleatorios sí considera la información de que las empresas son observadas en períodos diferentes de manera que el término de error aleatorio se puede descomponer en dos partes, incluyendo uno que caracteriza a la empresa y es invariante a lo largo del tiempo (Green, 1999; Wooldridge, 2002). De este modo es posible controlar la heterogeneidad individual, ya que cada error aleatorio puede ser interpretado como el conjunto de factores no incluidos en la regresión, pero que son específicos a cada empresa (Greene, 1999).

En esta investigación, la naturaleza y características de los datos panel con la variable dependiente censurada hicieron necesaria la elección de un panel de efectos aleatorios sobre uno fijo. El primero supone que los coeficientes varían dependiendo del agente social o del momento en el tiempo de modo que se permite investigar la variación intertemporal y/o transversal por medio de distintos términos independientes. Es importante mencionar que se utilizaron valores rezagados

de las variables tecnológicas, ya que la transferencia de tecnología no es instantánea (Mansfield, 1985).

4. Resultados

Los resultados de la estimación de los modelos econométricos propuestos en esta investigación se muestran en esta sección. El cuadro 2 muestra la matriz de correlación entre las variables dependiente e independientes del modelo de abastecimiento tecnológico. Esta matriz busca probar que no hay una relación lineal exacta entre las variables del modelo de abastecimiento tecnológico que pudiera generar problemas de especificación.

Cuadro 2. Matriz de correlación: abastecimiento tecnológico

	DINN	RHID	GID	PAT
DINN	1.0000			
RHID	0.1632	1.0000		
GID	0.2117	0.7594	1.000	
PAT	0.0802	0.7371	0.7797	1.0000

De igual forma el cuadro 3 muestra la matriz de correlación entre las variables dependiente e independientes del modelo de capacidad de absorción. De igual forma, esta matriz busca demostrar que no hay una relación lineal exacta entre las variables del modelo de capacidad de absorción que pudiera generar problemas de especificación.

Cuadro 3. Matriz de correlación: capacidad de absorción

	DINN	ACT	ED	LIQ	SOLV
DINN	1.0000				
ACT	-0.0960	1.0000			
ED	0.1803	0.1376	1.0000		
LIQ	0.4280	-0.1363	0.1539	1.000	
SOLV	0.3682	0.1349	0.2443	0.5858	1.0000

Finalmente, el cuadro 4 presenta la matriz de correlación entre las variables dependiente e independientes del modelo de variables de control. También busca probar que no hay una relación lineal exacta entre las variables del modelo de variables de control. En consecuencia, en los tres modelos las matrices de correlación entre variables demuestran la ausencia de multicolinealidad.

Cuadro 4. Matriz de correlación: variables de control

	DINN	IDMX	PIBMX	IMPMX	PIBR
DINN	1.0000				
IDMX	0.5513	1.0000			
PIBMX	-0.2632	-0.1241	1.0000		
IMPMX	0.1723	0.2360	0.7797	1.0000	
PIBR	0.5171	0.7506	-0.1062	0.1240	1.0000

El modelo de abastecimiento tecnológico se construyó a partir de la premisa de que la tecnología se transfiere desde el país receptor en donde se instalan las empresas subsidiarias de las ETNMX.

Este proceso de transferencia tecnológica puede darse a través de ciertos mecanismos, entre los que destacan: (i) la colaboración con otras empresas locales, (ii) las relaciones con proveedores de insumos en los países receptores, (iii) la disponibilidad de maquinaria y equipo más avanzados, (iv) la contratación de personal extranjero calificado, entre otros. El conocimiento obtenido a través de estos mecanismos tiene el potencial de ser asimilado por las empresas subsidiarias y transformarse posteriormente en innovaciones. Sin embargo, la identificación y medición de estos mecanismos de colaboración e interacción no se discuten en la presente investigación, abriendo futuras líneas de investigación. El cuadro 5 presenta los resultados de la estimación del modelo econométrico de abastecimiento tecnológico.

Tabla 5. Modelo de abastecimiento tecnológico

Variables independientes	Variable dependiente: DINN		
	Coeficiente	Error estándar	Estadístico Z
RHID ₋₁	-0.0366	0.0492	-0.74**
GID ₋₁	0.3425	0.0756	4.53***
PAT ₋₁	0.1079	0.5748	-1.88***
Constante	0.6866	0.2868	2.39***
Logaritmo de Máxima Verosimilitud	-280.46		
Chi ² de Wald***	23.84		
Sigma u	0.3000	0.0767*	3.91***
Sigma e	0.6751	0.0401*	16.80***
Rho	0.1649	0.0716	

*p > z = 0.000 al 95% de confianza.

**p > z = 0.000 al 90% de confianza.

*** Prob > Chi² = 0.0001.

Los signos esperados de los coeficientes de las variables independientes sobre la dependiente son casi todos positivos de acuerdo con la teoría, pero con excepción de la variable RHID. En este caso, se observó que la variable RHID tiene un peso negativo casi nulo sobre DINN. Una posible interpretación de este resultado sugiere que, con un nivel de confianza al 95%, el personal conformado por investigadores y personal calificado para realizar actividades de I+D por las subsidiarias de las ETNMX en los países receptores no son una fuente importante de abastecimientos tecnológicos y no explica las transferencias inversas de tecnología. La implicación más importante de este resultado es que las empresas subsidiarias de las ETNMX no se guiaron por la posibilidad de obtener conocimientos o *know-how* a través de contactos con investigadores y otros empleados calificados relacionados a actividades de I+D en los países receptores. Este resultado cobra sentido si se considera que en el año 2010 más de la mitad de las 223 subsidiarias de las ETNMX se ubicaron en países de América Latina en donde los recursos empleados en I+D no son altamente significativos (RICYT, 2010).

El resultado del parámetro que acompaña a la variable GID sugiere que la motivación de las empresas subsidiarias de las ETNMX por establecerse en otros países se explica en buena medida por su gasto

en I+D. De esta forma, cuando el monto de dicha inversión en el año previo aumenta en un punto porcentual, el DINN de las ETNMX aumentará en aproximadamente un 0.34%. Efectivamente, cuando las empresas subsidiarias de las ETNMX invierten montos considerables en actividades de I+D en los países receptores, es más probable que estas subsidiarias puedan absorber nuevos conocimientos y tecnologías para ser transferidos a sus empresas matrices en México.

El resultado de la estimación del coeficiente que acompaña a la variable PAT sugiere que esta variable influye de manera positiva en las decisiones estratégicas que toman las empresas subsidiarias de las ETNMX por instalarse sólo en ciertos países. Existen dos elementos en la explicación para este resultado. Primero, al igual que la variable RHID y dado que más del 50% de las empresas subsidiarias de las ETNMX se ubican en América Latina, la motivación por instalarse sólo en ciertos países pudiera ser una explicación poco sostenible por el escaso nivel de patentes que se observa en esta región. Segundo, sin embargo, es un hecho que a través de convenios internacionales las patentes pueden utilizarse en casi cualquier parte del mundo y no solamente en el país en donde se originan.

Cuadro 6. Modelo de capacidad de absorción

Variables independientes	Variable dependiente: DINN		
	Coeficiente	Error estándar	Estadístico Z
ACT	0.0278	0.0139	-0.70
ED	1.2062	0.2801	4.31***
LIQ	0.3558	0.0961	3.70***
SOLV	0.1085	0.0358	3.03***
Constante	-1.6844	0.4443	-3.79*
Logaritmo de Máxima Verosimilitud	-235.69		
Chi ² de Wald***	101.08		
Sigma u	0.6437	0.1717	3.75***
Sigma e	0.5519	0.0324	17.03***
Rho	0.5762	0.1332	

*p > z = 0.000 al 95% de confianza.

**p > z = 0.000 al 90% de confianza.

*** Prob > Chi² = 0.0000.

El cuadro 6 presenta los resultados de la estimación del modelo de capacidad de absorción incorpora variables que muestran características propias de las ETNMX en relación con su capacidad de absorción. Un acercamiento preliminar a la interpretación de estos resultados sugiere que las ETNMX además de expandir sus mercados, también buscan captar nuevos conocimientos y tecnologías en el extranjero a través de particularidades propias. Al igual que en el modelo de abastecimiento tecnológico, los signos esperados de los coeficientes de las variables independientes sobre la dependiente en el modelo de capacidad de absorción son los esperados de acuerdo con la teoría con excepción de la variable ED. Efectivamente, el coeficiente de la variable independiente ED significa que los años de operación que tienen las ETNMX en el mercado no influyen en su capacidad de

absorción y que les permita desarrollar un mayor número de innovaciones. Este resultado cobra sentido ya que la muestra incorpora a empresas con fechas de fundación no homogéneas (el promedio de edad de la muestra es de 62 años, la empresa más antigua tiene 107 años de operación y la más joven tiene sólo 15 años de operación).

Por su parte, la variable independiente ACT no resultó ser estadísticamente significativa, por lo que puede inferirse que la base de activos para el caso de las ETNMX no implica una mayor probabilidad de ampliar su capacidad de absorción. La variable LIQ muestra un efecto positivo en el desempeño innovador conforme al signo esperado. Este resultado implica que por cada unidad de aumento en el coeficiente de liquidez habrá un aumento de 0.35% en el desempeño innovador de las ETNMX. Es importante señalar que a partir de estudios previos que han incluido esta variable, se podría inferir que las ETNMX serían altamente sensibles a la presión financiera de corto plazo y, por lo tanto, esto podría incidir negativamente en la generación de innovaciones. De igual forma, la alta heterogeneidad que existe en la variable independiente LIQ (debido a la presencia en la muestra de ETNMX pertenecientes a diferentes sectores) sería otro factor que modificaría los resultados obtenidos en esta investigación (Chen et al., 2012). Sin embargo, es importante señalar también que la construcción de la muestra para esta investigación no distinguió sectorialmente el origen de las ETNMX. Este procedimiento fue necesario ya que no había otra forma de conformar una muestra suficiente grande que permitiera analizar de forma más robusta el desempeño innovador de las ETNMX y la medición de las derramas tecnológicas inversas. El parámetro que acompaña a la variable independiente SOLV presentó el signo esperado. En este sentido, un aumento en un 1% en el coeficiente de SOLV aumentaría en 0.10% el DINN. De esta forma, sería de esperarse que las ETNMX desarrollarán una mayor capacidad de absorción en el largo plazo y un mayor margen de maniobra para invertir en actividades de I+D incrementando su potencial innovador.

Cuadro 7. Modelo con variables de control

Variables de control	Variable dependiente: DINN		
	Coeficiente	Error estándar	Estadístico Z
IDMX	-1.058	0.6973	-4.14*
PIBMX	25.26	2.0747	10.54*
IMPMX	0.521	0.2137	0.18**
PIBR	0.263	0.0087	0.71**
Constante	-110.118	13.0671	-8.95*
Logaritmo de Máxima Verosimilitud	-77.74		
Chi2 de Wald***	53.01		
Sigma u**	0.0608	0.0261	2.17
Sigma e	1.2214	0.7405	17.44
Rho	0.0035		

*p > z = 0.000 al 95% de confianza.

**p > z = 0.000 al 90% de confianza.

*** Prob > Chi2 = 0.0000.

Finalmente, el cuadro 7 presenta los resultados de la estimación del modelo con variables de control. Debe recordarse que estas variables buscan captar los contextos económicos de México y de los países receptores de las empresas subsidiarias de las ETNMX. La variable IDMX se incluyó para probar si el contexto tecnológico global de México pudiera tener algún impacto en el desempeño innovador de las ETNMX. Los resultados muestran que el nivel de inversión en I+D en México tiene un peso negativo en DINN. Este resultado puede explicarse por el hecho de que la inversión en I+D en este país se caracterizan por ser muy deficiente y tomaría mucho tiempo ver reflejado sus efectos en la generación y desarrollo de innovaciones. Por otro lado, la percepción del crecimiento económico en México, medido a través de la variable PIBMX, muestra un impacto positivo sobre DINN. Este resultado podría explicarse por la confianza que otorga el dinamismo de la economía mexicana para la materialización de inversiones y el potencial desarrollo tecnológico en el corto plazo. Por su parte, la variable independiente IMPMX, aunque con un signo diferente al esperado, no presenta significancia estadística y por esta razón se descartó. Es importante señalar que otros estudios han incluido esta variable para demostrar que la tasa de recaudación puede incidir negativamente en el gasto en I+D, ya que los pagos por conceptos de impuestos no dejan margen para invertir y generar innovaciones (Hall, 1993). El resultado obtenido con relación al signo del parámetro que acompaña a la variable independiente PIBR muestra un impacto positivo conforme a lo esperado sobre la generación de innovaciones en las ETNMX. La explicación de este resultado se justifica por el hecho de que el crecimiento de las economías en donde se instalan las empresas subsidiarias de las ETNMX genera condiciones más adecuadas para la inversión y el desarrollo de innovaciones.

5. Conclusiones

En este trabajo se analizó la existencia de derramas tecnológicas inversas y su impacto en el desempeño innovador de las ETNMX. Los resultados obtenidos muestran evidencia de la influencia que tienen las transferencias tecnológicas inversas para elevar la capacidad innovadora de las ETNMX. Estos resultados se obtuvieron a partir de tres modelos econométricos: abasto tecnológico, capacidad de absorción y modelo con variables de control. El primer modelo prueba el abastecimiento tecnológico tomando en consideración el gasto en I+D como una variable clave que explica las decisiones inversión que toman las ETNMX en la búsqueda por nuevos conocimientos y tecnologías en mercados extranjeros. Por su parte, el modelo de capacidad de absorción incorpora variables que miden la capacidad que tienen las ETNMX para hacerse llegar de nuevas tecnologías y conocimientos. El impacto positivo que tienen las variables ACT y SOLV en el DINN cobra sentido cuando se considera la importancia que tiene para las ETNMX la estabilidad financiera y poder llevar a cabo actividades de I+D, así como la adquisición de nuevas tecnologías. Los resultados de LIQ y ED, éste último contrario al signo esperado, son factores que solamente opera en el corto plazo, mostrando que las ETNMX evitan tomar riesgos excesivos al invertir en nuevos desarrollos tecnológicos e innovaciones.

Finalmente, el modelo con variables de control es un referente en relación con el contexto económico de México y la percepción de crecimiento económico de los países receptores. El impacto negativo de IDMX, contrario al signo esperado, explica los montos escasos que se destinan a las actividades de I+D en México. De hecho, las empresas mexicanas perciben este hecho como una falta de apoyo gubernamental para llevar a cabo desarrollos innovadores en México. Sin embargo, la variable PIBMX incide favorablemente en la generación de desarrollos tecnológicos e innovaciones. La poca significancia estadística que tiene la variable IMPMX tiene un impacto moderado en el DINN. Finalmente, la variable PIBR sugiere que, a mayor nivel de PIB en los países receptores, mayor será el potencial para generar nuevos desarrollos tecnológicos e innovaciones por parte de las ETNMX.

Este trabajo abre futuras líneas de investigación. Por ejemplo, deberían analizarse cómo las políticas públicas podrían incentivar la expansión de las empresas mexicanas en otros mercados extranjeros y no solamente en los de exportación con el fin de aprovechar el conocimiento científico y los desarrollos tecnológicos provenientes de esos mercados. En este sentido, se deberían destinar recursos importantes para que las ETNMX fortalezcan su posición competitiva en los mercados internacionales. En este sentido, muchos gobiernos extranjeros han iniciado una nueva etapa de apoyos a sus empresas ofreciéndoles subsidios, préstamos, incentivos fiscales y otros mecanismos de financiamiento para promover la inversión (*outward FDI*) en otros países. Finalmente, otra futura línea de investigación debería analizar las estrategias más adecuadas que deberían tomar las ETNMX para establecer mecanismos de colaboración con otros actores de las economías más avanzadas y así aprovechar los desarrollos tecnológicos y el conocimiento que se genera en esas economías.

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Defense System, Industry and Academy: The Conceptual Model of Innovation of the Brazilian Army

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Abstract: This article intends to identify the technological parks existing in the headquarters of military regions of the Brazilian Army, with the premise that these habitats are capable of forming nuclei of governance of technological innovation. The problem is that since the year of 2016, the Brazilian Army created the Defense, Industry and Academy System (SisDIA) of Innovation, a conceptual model of the Triple-Helix, aiming to promote the development of innovations taking advantage of the Army presence in all regions of the country. For that, methodologically, it was chosen to conduct a research with an exploratory, qualitative and descriptive approach, and the case study of the Brazilian Army. It was possible to conclude that through SisDIA and the implantation of governance nuclei of innovation in the Brazilian Army, inserted in technological parks, there will be a possibility of interaction between the Triple-Helix (government-industry-academy), in a collaborative way, intending to reinforce the scientific and technological expression of the actors involved and to boost the development in social and economic dimensions according to regional potentialities.

Keywords: innovation ecosystems; triple-helix; technological parks; governance; Brazilian Army

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Introduction

Promoting the development of innovations has shown a perennial challenge to public and private organizations, in a way that the access and perspective of the gains in innovation are increasingly been inserted in the national and international scenarios. The innovative process is a boost for business growth and increases competitiveness. The search for environments that provide an opportunity to implement new products and services or spaces to access scientific knowledge and technology is becoming paramount.

The institutional spaces of development of innovative enterprises are usually called innovation habitats. Technological Parks (TPs) are favorable environments that have a fundamental role in the economic development, being favorable places to exchange knowledge, practices of production and the development of relationships among entrepreneurs of innovation, be they governmental, educational or from companies. Similarly, it is stated that they may arise in the institutionalization of Triple-Helix (TH) according to Henry Etzkowitz and Loet Leydesdorff (2000) writings, when they describe a relationship between government, industry and academia (G-I-A).

For a TPs to carry out its functions in order to respond to the requirements of its respective participations, it is mandatory to have a consolidation of good governance practices. Based on its principles and concepts, such practices include the technology sector, a knowledge-promoting initiative, entrepreneurs, government and cooperation among stakeholders.

Given this initial context, this work is justified by the possibility of contributing to studies on the management of innovation in the

military area, with the case of the Brazilian Army, due to its strategic nature, and to demonstrate that military innovation can contribute to local and regional development, through technological innovations and the production of military employment material, as well as allowing these innovations to foster the national defense industry.

It is also verified, in a seminal form, that there is a need to propose a model of governance structure of technological innovation for the Brazilian Army, due to the Brazilian territorial extension and its role in economic, urban and regional development, aligned with promotion of its strategic capacity and the institutional vision of acting on the frontier of dual technology and open innovation.

Therefore, it is of interest: *How can the model of the Triple-Helix, implemented by the Brazilian Army, called SisDIA, contribute to the structure and the promotion of innovation in defense of existing habitats in the headquarters of Military Regions?* To answer this question, a survey was made in the literature and on the concepts of technological parks, concepts of governance and networks of governance. This survey provided the theoretical support for the purpose of this work.

The article is divided into four sections. In addition to this introduction, section 2 presents the methodological aspects; section 3 reviews the literature on innovation ecosystems, technology parks, governance concepts, and networks. The section 4 describes the System of Science and Technology and Innovation of the Brazilian Army (SC-TIEx) and its structure; and in the section 5, a model is proposed for structuring a Nucleus of Governance of Technological Innovation of the Army. Finally, the section 6 presents the final considerations of the article.

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Method

The method used, in consonance with the taxonomy used by Vergara (2004), was based on two criteria: the purposes and the means. As for the purposes, the research can be classified as exploratory, once the proposal of a governance of innovation model for the Brazilian Army, from a perspective of concepts of Innovation Ecosystems (IE) and Triple-Helix (HT), in addition to never being published; it lacks an initial base and subsequent theoretical-applied deepening. As for the means, the investigation has a documental approach, developed by analysis of reports and studies published at the website from the Ministry of Science, Technology Innovation and Communications (MCTIC), the International Association of Science Parks and Areas of Innovation (IASP) and the National Association of Entities that Promote Innovative Enterprises (Anprotec), besides the institutional documents of the Brazilian Army that did not receive a analytic treatment, as for the legal rules and regulation activities of innovation and technology from the Brazilian Army. Aiming to find the answer for the problem-question of the research the case study strategy was chosen. In this paper, the case analyzed was that of the headquarters of the Military Regions of the Brazilian Army and a survey of the Technological Parks existing in these headquarters, intending to verify the potentialities of these innovation habitats and the implementation of Nucleus of Governance of Technological Innovation, in particular, in the city of Curitiba, as for the possibility of these authors to carry out the research by a direct and participative observation.

Innovation Habitats

Innovation habitats are environments that offer incentives for entrepreneurial development in the various phases of the company, since the beginning until the consolidation of a large organization focused on technology and innovation. Entrepreneurs seek these environments to establish cooperation with universities and research centers, sharing knowledge and developing innovation projects. Habitats consist of pre-incubators, business incubators and technology parks.

Specifically, the focus of this study will be the Technology Parks (TPs), with the premise, and according to the literature researched, that these innovation habitats are the most favorable to create interaction between universities, companies, development agencies and the government.

The International Association of Science Parks (IASP, 2010) defines technology parks as an organization managed by specialized professionals, with the fundamental objective of increasing the wealth from its community by promoting the culture of innovation and the competitiveness of companies and institutions that generate knowledge.

Based on the interaction between universities and the private enterprise, technology parks aim to promote a technical, logistical and administrative infrastructure to help companies develop their products, increase competitiveness and favor technological transference and the creation of a proper environment to innovation (Bakouros, Mardas & Varsakelis, 2002).

Therefore, the focus of PqTs is to stimulate the economy based on knowledge, creating a synergistic environment and confiability between universities and businesses in order to increase the possibilities of flow between knowledge assets (Labiak Junior & Gauthier, 2010). In this perspective, the TPs located in several regions of the country and, in areas near universities and research centers, aim the implementation of infrastructure for research laboratories, services and support to companies in the process of technological development and innovation.

Contribution of Technology Parks in the formation of Innovation Ecosystems

Innovation ecosystems (EI) are characterized as proper environments to entrepreneurship, through the continuous development of innovations, spaces for collective learning, exchange of knowledge and productive practices, and of synergy between the various agents of innovation (Spinosa et al, 2015).

Recently, the Decree 9.283, of February 7, 2018, conceptualized the IE as

[...] spaces that add infrastructure and institutional and cultural arrangements that attract entrepreneurs and financial resources are places that enhance the development of the knowledge society and include, among others, science and technology parks, smart cities, innovation districts and technological poles (Brazil, 2018).

Over the time, poles and technology parks have been presented as important tools for boosting developed economies, and also the ones in development, following the success of experiments such as Silicon Valley in California and Route 128 in Massachusetts in USA. Something that is common to the PqTs is the presence of several agents represented by the tripod: government, industry and academia (G-I-A) in intense interaction.

The Route 128, near Boston, still remains as the unifying element for GIAs in the region, particularly at the Massachusetts Institute of Technology (MIT) and at Harvard University. As pointed out by Dorfman (1983, in Barbieri, 1995) this cluster emerged spontaneously, unlike the Silicon Valley that was carefully nurtured by Stanford University under the leadership of Frederick Terman in the early 1950s.

Among the factors that contributed to the formation of the cluster of technology-based defense companies around Route 128, besides the availability of highly qualified human resources by local GIAs and technological infrastructure, the existence of venture capital in abundance in the region was preponderant in the Boston area (Dorfman, 1983 in Barbieri, 1995).

It should be highlighted that the experiences of Silicon Valley and Route 128 promoted the idea of technological parks as inductors and facilitators in the formation of innovation ecosystems through the interaction between the Triple-Helix researches (government-industry-

academia) and the needs of the productive and governmental sectors. Despite their diverse names - technology centers, high technology centers, hatcheries, techno parks or scientific cities, science and technology parks - or simply technology parks, this habitat seeks to foster technology transference and innovation, competitiveness of compa-

nies, regions and even nations (Hassink & Hu, 2012). The definition, objectives, as well as the advantages and disadvantages of Technological Parks were synthesized and compiled in Table 1, according to data from IASP (2010) and Do Nascimento and Labiak Junior (2011) studies.

Table 1. Characteristics of Technologic Parks. Adapted from IASP (2010) and Do Nascimento and Labiak Junior (2011).

Definition		Objectives
Technologic Parks	An organization managed by specialized professionals, with the fundamental objective of increasing the wealth of its community by promoting a culture of innovation and competitiveness of companies and institutions that generate knowledge [...] (IASP, 2010).	Act like a link between the university and the companies located in the park. Bring together entrepreneurs and researchers and generate knowledge flow among these agents. Connect entrepreneurs and students with the potential to work in the park companies, due to their proximity to universities. To house companies in harmony with the environment, generating little or no waste. Influence the region where it is located, through the development of the economy based on knowledge.
Advantages		
* Stimulate social and collective awareness of the importance of technology and innovation. * Work with network concept. * Encouraging quality culture in the global management of enterprises. * Possibility of access to a vast network of contacts, including international ones. * Contact with people of high added value, interested in generating synergy for innovation.		
Disadvantages		
* In some cases, interaction with universities is less than desirable. * Some parks have an excessively "real estate" aspect, not enhancing the integration with the other actors of the park, such as universities and research centers. * Limited presence of development agents or venture capitalists.		

In relation to the objectives, it is emphasized that the training of the human resources that work in the companies located in the TPs is a competitive differential, especially when it is considered that initiatives directed

to technological innovation do not dismiss professionals that support the technical development of the companies (MCTI, 2004). In table 2 it is possible to identify some supports offered by the Technology Parks.

Table 2. Supports offered by Technology Parks. Elaborated from IASP (2010) and Do Nascimento e Labiak Junior (2011).

Consulting and services in the areas of business management.	Guidelines on Intellectual Property.
Advising of processes to encourage innovation.	Assistance in communication and marketing projects.
Access to park network and partners.	Access to training in foreign languages, courses in Innovation Management, among others, with differentiated costs.
Links with international parks networks.	Organization of business rounds.
Provision of resources through funds or special lines of financing.	Support for the internationalization of business.
Proximity with funds from Venture Capital and Angel Investments.	Physical infrastructure: auditoriums, meeting rooms and videoconferencing, Internet (fiber optics), restaurants, living environment, banks, among others.
Assistance in the structuring of projects for the use of governmental tax incentives and fundraising.	Urban parks in areas with municipal tax and tax incentives, such as reduction of ISS, IPTU and ITBI.
Safe environment.	

With the support offered by the TPs, the companies remain connected with opportunities for development existing in the country, made available in public notices, and integrate part of a network of competitive companies that develop innovations in a cooperative way.

Concepts, Structure and Models of Governance

The concept of governance refers to the different ways in which individuals and organizations (public and private) manage their common issues, adjusting conflicting or distinct interests through cooperative actions (Cassiolato & Lastres, 2003). Governance can also be characterized by an institutional coordination process, consisting of formal and/or informal mechanisms, providing solutions to problems that go beyond the limits of economic relations (Menezes & Vieira, 2011).

In this study, the governance concept of Suzigan et al. (2007) was adopted, as the capacity of command or coordination that agents or institutions exert over productive, commercial, technological and other interrelationships, decisively influencing the development of the local system or arrangement.

Regarding the definition of governance structure, Buainain et al. (1999) describe it as a set of organizational forms that condition the relationship between agents that are engaged in an activity, determining individual incentives and allocating available resources.

The governance structures vary depending on the type of production system in each region. This, by its turn, is determined by the structure of production, agglomeration of companies, coordination among agents, penetration of industries in the market, institutional density and the social tissue of the region (Suzigan et al., 2007).

Storper and Harrison (1991) associate these governance structures of productive agglomerations to the degree of hierarchy, leadership and command (or collaboration and cooperation) exercised by the firms in the coordination of these relations with other companies participating in the system.

In the context of the innovations, Carvalho, Cavalcante and Reis (2009) point out three internal elements of the organizations that make it possible to take advantage of these opportunities: i) the environment conducive to innovation; ii) creative people (entrepreneurs, contributors and employees), prepared and stimulated to innovate; and, iii) the systematic and continuous process (or method) of innovation. It is noted that in all these elements people are considered the fundamental element.

However, other assets have an important contribution to the capacity of innovation, such as public policies, investments and incentives of the government, articulation between associations and federations of companies, opening of universities and institutes to create partnerships to finance and foster innovation (Carvalho, Cavalcante & Reis, 2009). Thus, intersectoral partnerships have several denominations. Some authors call these partnerships as intersectoral collaborations (Bryson, Crosby & Stone, 2006); collaborative public management (McGuire, 2006); collaborative governance (Ansel & Gash, 2008); or intersectoral partnerships to address social issues (Selsky & Parker, 2005).

Collaborative governance, by its turn, became a reference for studies on collaborative public management, government networks, multiparty governance and hybrid sectorial arrangements (Ferreira, 2015). The collaborative governance model proposed by Ansell and Gash (2008) is an analytical framework based on a contingency approach that aims to provoke the questioning of contextual conditions, that is, whether they facilitate or discourage the results of the partnership.

According to Cabral, Krane and Dantas (2013), the governance model proposed by Ansell and Gash (2008) is one of the most accepted in the literature and suggests that some factors influence the collaborative process, in other words:

Firstly, there is the importance of the initial conditions for collaboration, which encompasses the prehistory of cooperation and the asymmetries of power, resources and knowledge between the parties, which together shape the incentives and constraints for participation.

In parallel, there is the institutional design that surrounds the collaborative process composed of the rules of participation, conditions of inclusion of actors, as well as aspects related to the accountability of the agents and transparency of the collaborative process.

A third relevant component is the presence of facilitating leadership so that the various stakeholders can commit to interorganizational collaboration (Cabral, Krane & Dantas, 2013, pp. 147-48, emphasis added).

These three components feed into the collaborative process itself, within which a cycle is initiated by face-to-face dialogues, which in its turn stimulate the building of the mutual trust necessary for the commitment of the various stakeholders to the process of collaboration and the shared understanding of the missions, problems and common values, which lead to small intermediate victories capable of reinforcing the cycle of the cooperation process, until the final result of collaborative governance is obtained.

The collaborative process encourages the building of the mutual trust necessary for the commitment of the various stakeholders to the process of collaboration and the shared understanding of the missions, problems and values in common, which lead to small intermediate victories capable of reinforcing the cycle of the collaborative process until the final result of collaborative governance is achieved (Cabral, Krane & Dantas, 2013).

With decisions taken in a shared way, the governance of multiple organizations engaged in collaborative processes is characterized by the intense participation of its members, depending almost exclusively on the involvement and commitment of their components, even though they have different characteristics.

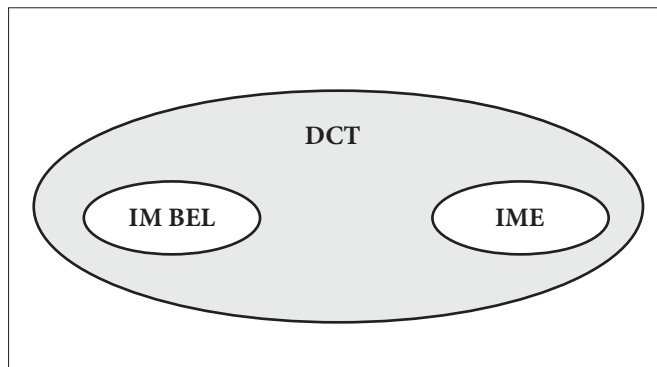
The Brazilian Army's Science, Technology and Innovation System

The vision of the Brazilian Army (BA) that integrates the Terrestrial Military Policy, projects that by the year 2022 a new doctrine will be reached - with the use of technologically advanced defense products, highly trained and motivated professionals - so that the Army, with appropriate tools, faces the challenges of the 21st century, supporting the sovereign decisions of Brazil in the international arena (Brazil, 2013).

The need to implement a new and effective Brazilian Army Science, Technology and Innovation System (SCTIEx) is based on two concepts: i) that the current system does not favor the generation of innovations, in the quality and quantity demanded by the Army Transformation Process; and, ii) the indication that the current model "directs the System's effort, in a prevailing way, to meet the current needs of the Army, with little adherence to the PD & I cycle" (Brazil, 2012, p. 32). In a study by Prado Filho (2014), the author points out that the lack of alignment of these conceptions has caused a mismatch between the expectations of the Brazilian Army and the deliveries of the products in the System.

In BA, the Triple-Helix of SCTIEx was structured according to the statist model of Etzkowitz and Leydesdorff (2000), and the government, represented by the Brazilian Army, through the Department of Science and Technology (DCT); the industry, represented by the Military War Industry (IMBEL); and the academy, represented by the Military Engineering Institute (IME). Figure 1 illustrates the composition of this model.

Figure 1: Triple-Helix of SCTIEx (*Statist Model*). Author's elaboration.



With the new SCTIEx, the organizational characteristics will be presented as effectively innovative, integrated with the internal and external environments to the Army, oriented to the future, with emphasis on results, and fully aligned with the needs of the Terrestrial Force (Brazil, 2012). In the model of the Triple-Helix, called balanced (Etzkowitz & Leydesdorff, 2000), institutions are more autonomous, making relations more symmetrical, reciprocal and cooperative, that is, the limitations of each of the actors can be suppressed or softened by the other, making it extremely healthy for the creation of new development strategies and innovation practices.

The Brazilian Defense System, Industry and Academy System

The Brazilian Army has sought its modernization and transformation to raise higher altitudes, and it is becoming obvious that it is necessary to reduce, if not neutralize, the technological differences that lead to relevant disadvantages to the maintenance of national interests.

In order to achieve its objectives, the Army, in 2016, through its Department of Science and Technology (DCT), established the Defense System, Industry and Academia (SisDIA) of Innovation, with a national scope, aiming to increase cooperation between these areas, acting in the promotion of actions that aim the generation of opportunities for the development of brand new technologies for the Defense Area with dual technology applicability (DCT, 2017).

Figure 2. SisDIA of Innovation from Brazilian Army (Logo). DCT (2018).



In order to achieve the National Defense goals for innovation and technology, SisDIA will act according to the levels presented in Table 3.

Table 3. Levels of SisDIA performance. Data from DCT (2018).

Local level	Regional level	National level
Execution of Army projects and/or contributes to Local Productive Arrangements (LPAs).	Operational strategic level, which stimulates the regional potential of industrial and academic propellers.	Strategic level, which focuses on the efforts of the government propeller sectors.
Actors: BA, Industries, Universities, Poles or Parks of S&T, Incubators of companies and LPAs.	Actors: BA, Federations of Industries, SENAI, Universities and Development Agencies.	Actors: BA, Ministries, National Confederation of Industries, Development Agencies.
Operational performance.	Strategic-operational performance.	Political action.
Execution of projects	Meetings, seminars, visits.	Meetings, seminars, visits.
Best characterization of the Triple-Helix.	Technological prospecting.	Identification of opportunities.
	Identification and support for possible LPAs.	
	Identification of partners to receive technology.	

Regarding the performance levels, some gaps can be observed and deserve to be highlighted, such as the lack of prediction and implementation of public innovation policies in the three spheres of government, and the definition of a governance model to structure the interaction between the various actors.

It is noted that with SisDIA, it will be possible to implement nuclei of technological innovation governance throughout the national territory, to benefit the socioeconomic potential of each region and the presence of Technology Parks. At Table 4 it is listed the host cities and states of jurisdiction in the twelve military regions of the Brazilian Army.

Table 4. Military Regions under the jurisdiction of the Brazilian Army. Data from Brazil (1999).

Military Region	Headquarters	Jurisdiction (Units of the Federation)	Military Region	Headquarters	Jurisdiction (Units of the Federation)
1st	Rio de Janeiro	Rio de Janeiro e Espírito Santo	7th	Recife	Alagoas, Pernambuco, Paraíba e Rio Grande do Norte
2nd	São Paulo	São Paulo	8th	Belém	Pará e Macapá
3rd	Porto Alegre	Rio Grande do Sul	9th	Campo Grande	Mato Grosso do Sul e Mato Grosso
4th	Belo Horizonte	Minas Gerais	10th	Fortaleza	Ceará, Piauí e Maranhão
5th	Curitiba	Paraná e Santa Catarina	11th	Brasília	Distrito Federal, Goiás e Tocantins
6th	Salvador	Bahia e Sergipe	12th	Manaus	Amazonas, Acre, Roraima e Rondônia

These military regions are commanded by General Officers, and are located in the main Brazilian capitals, revealing a factor that may impact integration with the various actors of the IE, since one of the duties of the Military Regions is to carry out, according to institutional guidelines of the Army, **studies** and **experiments**, aiming at the doctrinal improvement in the area of defense (Brazil, 1977, emphasis added).

In this context, it is argued that the Regional Commands are competent units to mediate the actions proposed by the Brazilian Army's

Science, Technology and Innovation System (SCTIEx). The results presented by the Ministry of Science, Technology, Innovation and Communications, in 2014, indicate that there is a positive relationship between the number of parks, the population contingent and the economic relevance of the region (MCTIC, 2014). In table 5, the quantity of PQTs existing in the host cities of the twelve Military Regions (table 4) are shown in order to demonstrate the potential of knowledge assets and the collaborative process of interorganizational governance.

Table 5. Technology parks in the headquarters of the Military Regions. (MCTIC, 2014 & Endeavor Brazil, 2017).

Region	State	Headquarter	Quantity	Total by Region
North	Amazonas	Manaus	01	04
	Pará	Belém	02	
	Mato Grosso do Sul	Campo Grande	01	
Midwest	Distrito Federal	Brasília	03	03
Northeast	Ceará	Fortaleza	01	04
	Pernambuco	Recife	02	
	Bahia	Salvador	01	
Southeast	Minas Gerais	Belo Horizonte	01	07
	Rio de Janeiro	Rio de Janeiro ⁽¹⁾	01	
	São Paulo	São Paulo e Região do ABC	05	
South	Paraná	Curitiba	02	10
	Rio do Grande do Sul	Porto Alegre e Região Metropolitana ⁽²⁾	06	
	Santa Catarina	Florianópolis ⁽³⁾	02	
Total				28

(1) Army Science and Technology Center in Guaratiba (PTEG).

(2) The municipalities of the Metropolitan Region of Porto Alegre that have TPs are Campo Bom, Canoas and São Leopoldo.

(3) It is not one of the headquarters of Military Region, but was considered in the year 2017, by the Index of Entrepreneurial Cities, Endeavor Brazil, the second most innovative city in the country. The methodology of the index is composed of the following factors: regulatory environment, infrastructure, market, and access to capital, innovation, human capital and entrepreneurial culture. In the Innovation factor, Florianópolis occupies the 3rd position in the research.

The concentration of parks in the Southeast and South regions is a reflection of the economic, social, educational and innovation indicators of these geographical areas. However, according to MCTIC (2014), there is room for initiatives to implement and consolidate PqTs in the north, north-east and mid-west regions, which, in addition to using local potential, can also benefit of existing differentials for the transformation of knowledge into products, processes and services with high added value.

By investing in initiatives that aim to reduce the national dependence on external knowledge, as well as increasing the autochthonous capacity for innovation, the BA has sought to establish that the scientific and technological advances support the consolidation of the country as an emerging power in the international arena (Ministry of Defense, 2017).

From the point of view of national defense, the scientific and technological development is fundamental for achieving greater strategic autonomy and better operational capacity of the Armed Forces - especially in the three strategic sectors for National Defense - nuclear, cybernetic and space.

Thus, in order to illustrate the premise of the case of this research, it was delimited to analyze the case of IE of BA in the city of Curitiba, state of Paraná. In it, there is the Technopark, linked to the Pontifical Catholic University of Paraná (PUCPR), that is to say, one of the blades of the Triple-Helix (Academy), constituting a space dedicated to the transfer and development of new technologies.

At Technopark, it is possible to install technology-based companies, in particular the Research & Development units. Its headquarters has a modern infrastructure of approximately 10.000m², and can be considered one of the most important technological hubs of Paraná and Brazil (Agência PUC, 2017).

Currently, there are 87 companies installed, generating approximately 16 thousand direct and indirect jobs, with investments totaling approximately R\$ 200 million. The Technopark Attraction Plan is composed of: i) institutional support and promotion network; ii) incentives for high-quality facilities for enterprises; iii) investments in marketing, connectivity and mobility; iv) strategic equipment offerings, supporting services, meeting and event centers; v) urban policy directed to the business sector; and vi) differentiated tax policy (Agência Curitiba, 2018).

In this way, the Technopark, linked to PUCPR, promotes the alignment with the various actors of society, either through the training and qualification of professionals, or through the production of research aligned with the needs of regional, state and national development.

In regard to Industry, the Federation of Industries of Paraná (FIEP), based in Curitiba, has been a promoting agent of the competitiveness of the industry from Paraná, acting as an integrator entity of the productive sector with the Academy, through actions promoted by the International Center of innovation (C2i).

Through FIEP it is possible to identify four major forces of interaction with the Brazilian Army: i) the expansion of the relationship between the industry of Paraná and the institution; ii) the identification and development of technologies and projects of interest for the formation of the Industrial Defense Base (IDB), in partnership with the Brazilian Association of Defense and Security Materials Industries (ABIMDE) and the Secretary of State for Industry, Commerce from Mercosul subjects, in Paraná (SEIM); iii) the induction and adaptations to the productive process of defense; and, iv) guarantee and institutional support in related demands.

Proposed Structure of a Nucleus of Governance of Technological Innovation for the Brazilian Army from the point of view of SisDIA

Aligned with the objective of this research, the creation of a Nucleus of Governance of Technological Innovation of the Brazilian Army (NuGITEc BA), as shown in figure 3, is suggested as an innovative proposal.

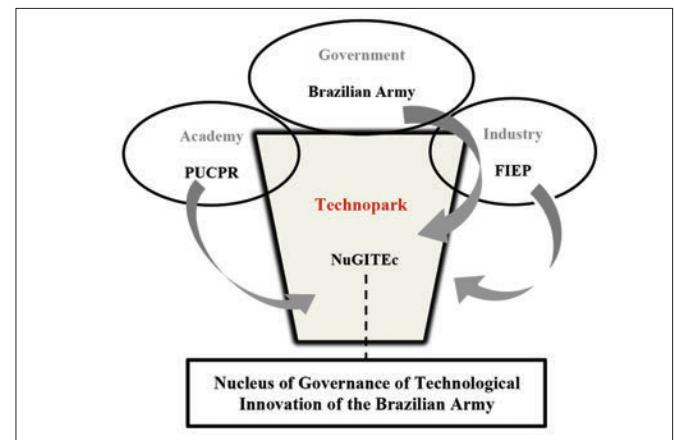
In this model, called collaborative governance, it is believed that it will be possible to foster and articulate the relationship between the various actors that belong to the innovation ecosystems at the headquarters of the Military Regions of the BA.

Specifically, in the case of Curitiba, the collaborative governance would be constituted from the perspective of the Triple-Helix by the - **Government** (5th Military Region Command) - **Technopark** (PUCPR) - **Industry** (FIEP), compounding the Nucleus of Governance of Technological Innovation of the Army (NuGITEc EB), with the purpose of leading and coordinating the collaborative process of implementation, consolidation and development of technology-based companies.

In collaborative governance it is essential to train leaders and the professionals who will work at the NuGITEcs in the process of innovation.

In this way, the nuclei can consolidate themselves as environments that aggregate the synergies of the elements of the Army Triple-Helix: Defense System, Industry and Academy (SisDIA).

Figure 3. Structure Model of the Nucleus of Governance of Technological Innovation of the Brazilian Army from the perspective of SisDIA. Author's elaboration.



In this model (figure 3), the following possibilities stand out: the development of dual employment technology products (military and civil) integrated with the defense industrial base; support from research development agencies; coordination and implementation of municipal and regional public policies to promote the activity of defense industries; coordination and orientation for technological compensation agreements, by aligning actions and disseminating the practice among the agents of the sector; and, strengthening SisDIA's innovation and technology in the Brazilian Army, in the state of Paraná, and in other headquarters of the Military Regions.

At NuGITEc, it will be the Brazilian Army, under the planning and coordination of the Department of Science and Technology (DCT), that will play the role of articulator in the interaction of SisDIA, in order to lead and stimulate the creation of partnerships and the availability of resources to support the enterprises focused on the production of new technologies, so that the universities and institutes of science and technology may take the lead in a collaborative way, having the Army as a support for the entrepreneurial actions, with the training of human resources of the institution itself.

The challenges outlined in an economic and political scenario that imposes a number of uncertainties should serve as a driving force for the implementation of the NuGITEcs BA in order to enhance the strategic-operational capacity and the search for productive capacities of defense systems and dual technologies in the Brazilian states.

In regard to resources, NuGITEcs will have to play the role of mediator in obtaining public and private funding so that technology-based companies have access to the research carried out in the academy and, at the same time, these companies can produce the necessary materials to meet the demands of the Brazilian Army.

One of the challenges that persist on the part of the companies is the fear of innovating, often explained by the economic conjuncture and the low information on the types of investment and financing. It will therefore be the responsibility of the NuGITEcs to encourage the acquisition of sources of resources in order to promote potential for the CT&I scenario at local and regional levels.

Final considerations

As presented in this study, the proposal of a structural model of a governance nucleus for the Brazilian Army, from the perspective of the Triple-Helix, possibly qualifies it as a consistent pilot project, in order to promote the interaction between Army-Industry-Academy, and generate innovation through the development of products strengthening the defense industrial base.

The collaborative governance model, inserted in the Technological Parks, aims to trigger actions and projects through the creation and implementation of technology-based companies and the achievement of the Brazilian Army's strategic objectives, through a process of modernization that is capable of promoting the constitution of a network of governance that establishes and disseminates the information and its demands.

The initiatives resulting from a formal and strategic planning, centered on the NuGITEcs, can attract consolidated companies and, at the same time, promote the creation of startups or accelerators in technological parks, thus contributing to social development and job and income generation.

The Technological Parks, located in the headquarters of the twelve Military Regions of the Brazilian Army, are thus innovative habitats capable of stimulating the economy based on knowledge, that intend to create an environment of synergy and trust between universities and companies, in order to increase the possibilities between knowledge assets in innovation ecosystems.

It is expected, therefore, that the NuGITEcs, besides reinforcing the scientific-technological expression of the actors involved, could potentiate regional economic expression with the expansion of opportunities arising from the commercialization of dual technology with high added value.

Given this context, it is suggested that the Brazilian Army Science, Technology and Innovation System (SCTIEx), through the NuGITEcs, seek a more autonomous relationship for the institutions involved, based on cooperation, trust, transparency and symmetry of the relations and, from this scenario, it can play the role of articulator either through the interaction between the various actors of the innovation ecosystem, or through sectorial public policies of innovation at the local and regional level, promoting, in a sustainable way, support to ensure and expand the proposed structural governance model.

Finally, in this study, developed in a seminal way, as a thesis project in the Post-Graduate Program in Administration (PUCPR), it allows the proposition of new studies that can identify the morphology of the proposed governance model in front of some scenarios, such as management of governance networks, identification and description of the responsibilities of each of the actors, as well as the mapping of collaborative processes that have produced innovative results.

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Digitalización y Modelos de Negocio en la Industria Editorial Española

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Abstract: Like other creative industries, the book industry is undergoing a technological change, going from analog to digital formats. This change challenges existing business models and encourages companies to reexamine their product and competency portfolios. Through a qualitative case study of three Spanish publishers, this paper investigates how digitization affects business models in the publishing industry. The functionality and user experience of digital products are still deficient: prices are still high, and the proportion of Spanish digital titles is still low. To all this is added the lack of a common dominant design for digital publishing, which on the whole, represents a substantial uncertainty for publishers, who are advancing, step by step, towards the digital age and whose exploration of new market opportunities and alternative business models remain anchored in the traditional ones. Finally, the document also analyzes how current institutions contribute to preserving the publication regime on paper.

Keywords: Digitalization; Publishing industry; Innovation; Business model; e-book; Spain

Resumen: Al igual que otras industrias creativas, la industria del libro está experimentando un cambio tecnológico, pasando de formatos analógicos a digitales. Este cambio desafía los modelos de negocio existentes e impulsa a las empresas a reexaminar sus carteras de productos y competencias. A través de un estudio de casos cualitativo de tres editoriales españolas, este trabajo investiga cómo la digitalización afecta a los modelos de negocio en la industria editorial. La funcionalidad y la experiencia del usuario de productos digitales aún son deficientes: los precios siguen siendo altos y la proporción de títulos digitales españoles es aún reducida. A todo esto, se añade la falta de un diseño dominante común para la publicación digital, lo que, en conjunto, representa una incertidumbre sustancial para los editores, que avanzan, paso a paso, hacia la era digital y cuya exploración de nuevas oportunidades de mercado y modelos de negocio alternativos sigue anclada en los tradicionales. Finalmente, el documento también analiza cómo las instituciones actuales contribuyen a preservar el régimen de publicación en papel.

Palabras clave: Digitalización; Industria editorial; innovación; modelo de negocio; libro electrónico; España

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Introducción

El libro como medio de comunicación cuyo soporte tradicional ha sido el papel, se encuentra actualmente ante una encrucijada provocada por la disrupción del nuevo soporte electrónico, el *ebook*, lo que implica la mayor transformación de la industria editorial desde Gutenberg y la aparición de la imprenta (Carreiro, 2010), desafiando los modelos de negocio existentes hasta el momento en la industria editorial e impulsando a las organizaciones a reexaminar tanto sus carteras de productos como sus competencias básicas.

En la última década, han aparecido nuevos productos vinculados al mercado del libro digital. Entre ellos, podemos destacar: el contenido fragmentado, el pago por consumo o contenido a la carta, el modelo de suscripción, la afiliación, el *crowdfunding*, la gamificación, la venta directa y la autoedición.

La economía digital ha incrementado significativamente la complejidad del contexto, otorgando a diversas tecnologías radicales -por ejemplo, Internet, dispositivos o tiendas de aplicaciones- un peso decisivo en los ecosistemas de innovación (Yoo *et al.*, 2012), lo que, a su vez, ha provocado un efecto disruptivo sobre las industrias existentes y los modelos de negocio prevalecientes (Benghozi y Lyubareva, 2014; Øiestad y Bugge, 2014). Por tanto, el sector se está

transformado y puede observarse una nueva forma de organización de las relaciones entre empresas del sector.

La teoría relativa a la innovación disruptiva ha subrayado cómo la introducción de nuevas tecnologías puede reestructurar industrias enteras y reemplazar los modelos de negocio prevalecientes (Christensen, 1997). Frecuentemente, tales transformaciones tecnológicas pasan por diferentes fases antes de establecerse un nuevo diseño dominante (Abernathy y Utterback, 1978).

Aunque las nuevas tecnologías y el comportamiento de los consumidores pueden requerir una reestructuración industrial y una reorientación del mercado, en muchos casos, tanto las empresas como las industrias se ven influidas en gran medida por sus acciones previas y sus especializaciones actuales. Tal interdependencia puede conducir a la miopía (Levitt, 1960) o al bloqueo de las carteras de productos (Fagerberg *et al.*, 2005).

La industria editorial, al igual que otras industrias creativas -como la musical (Hracs 2012), la cinematográfica (Currah, 2006) y la publicitaria (Bugge 2011; Evans, 2008;)-, están experimentando un proceso relevante de cambio tecnológico. De hecho, el mundo editorial está sufriendo una profunda transformación a raíz de la transición al mundo digital, tanto en el plano del producto que la misma ofrece

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como en los procesos de producción y de distribución al mercado, la cual se extiende a lo largo de toda la cadena de valor del sector editorial: desde la concepción misma de qué es lo que se entiende como libro, hasta sus formas de producción y distribución (Bockstedt *et al.*, 2006; Galuszka, 2015). La digitalización representa enormes desafíos para la industria de publicación de libros (Donoughue 2010) y es probable que reestructure la publicación tal como la conocemos (Lichtenberg, 2011; Tian y Martin, 2010).

La escasa investigación y teorización que, hasta ahora, existe sobre la digitalización de la publicación de libros se ha fundamentado principalmente en la literatura sobre la gestión de la organización. La literatura existente se puede dividir en dos grandes grupos: a) el relacionado con la gestión práctica de la digitalización a nivel empresarial (Carreiro, 2010; Sabatier y Fizzle, 2011) y b) el relacionado con la digitalización a nivel industrial o nacional (Bajandoh y Alamoudi, 2018; Xiaomei, 2011).

En una línea similar, la literatura sobre modelos de negocio también suele tratar la digitalización desde la perspectiva de la microgestión (Teece, 2010). Por lo tanto, con algunas excepciones notables (Lichtenberg, 2011; Shatzkin, 2008), pocas contribuciones combinan o conectan la empresa y el nivel de la industria. Existe una brecha de conocimiento con respecto a las relaciones entre los efectos de la infraestructura industrial y las políticas en la industria en general, y cómo estas condiciones se relacionan con las competencias, la innovación y los modelos de negocios a nivel de empresa (Øiestad y Bugge, 2014).

La industria editorial española es una de las más potentes de Europa y una de las de mayor proyección internacional, situándose como la cuarta potencia editorial del mundo (tanto en producción como en facturación), por detrás de Estados Unidos, Reino Unido y Alemania. Actualmente, casi cuarenta editoriales españolas tienen filiales en 32 países, principalmente en Iberoamérica (80%) y en Europa (13,3%). El sector editorial español aporta el 1,1% al PIB, suponiendo más del 34% del conjunto de las actividades culturales en España. La industria editorial es el sector que genera la mayor riqueza dentro de las industrias culturales. En el campo de las industrias culturales, el sector editorial ocupa un lugar clave gracias al volumen de negocio que genera, el número empleos que ofrece y las posibilidades de crecimiento y desarrollo que se pueden darse como consecuencia de las innovaciones y cambios tecnológicos a los que se enfrenta el sector.

En tal contexto, el objetivo general de este estudio es responder a la siguiente pregunta: ¿cómo afecta la digitalización a los modelos de negocio en la industria editorial de libros? A este objetivo general se vinculan los siguientes objetivos específicos: a) ¿Cómo adquieren los editores nuevos conocimientos para adaptarse a la era digital? y b) ¿En qué medida los arreglos institucionales, como las políticas culturales y las estructuras de propiedad, influyen en la digitalización de la industria editorial de libros?

El trabajo está estructurado de la siguiente manera: la sección dos proporciona un marco teórico para el estudio; la tercera sección describe el método aplicado; la sección cuatro presenta el estudio de

caso; la sección cinco discute los principales hallazgos del documento; y la sección seis resume las principales conclusiones.

Marco teórico

A continuación, se expondrán aquellas teorías relevantes sobre los modelos de negocio, sobre la digitalización de la publicación y sobre la gestión de la innovación, que constituyen el marco conceptual para el estudio de casos en esta investigación.

Modelos de negocio

Los modelos de negocio deben construirse sobre un plan lógico para llevar un producto al mercado y obtener un beneficio. En este sentido, las empresas tienen que innovar en sus respectivos modelos de negocio con nuevas formas de crear y capturar valor para sus grupos de interés (Sabatier *et al.*, 2010).

Una parte fundamental en la innovación de los modelos de negocio es la relativa a la innovación, ya que esta es el reflejo de los valores de una sociedad avanzada tecnológicamente, por lo que las organizaciones tienen que ajustar sus modelos de negocio a las nuevas realidades tecnológicas (Chesbrough, 2010; Teece, 2010).

Chesbrough (2010) sugiere que el modelo de negocio empresarial articula el mercado en el que actúa, ubicándolo dentro de una red de valor de proveedores y clientes. Por lo tanto, el modelo de negocio no solo proporciona la arquitectura lógica detrás de la producción y el suministro de un producto, sino que, además, aporta una comprensión y respuesta por parte de la empresa al mercado y sus necesidades (Øiestad y Bugge, 2014).

La digitalización en el sector editorial ofrece nuevas formas de presentar el contenido (Shatzkin, 2008) y permite que se puedan desarrollar nuevos modelos de negocio (Gordon *et al.*, 2008; Sabatier y Fizzle, 2011; Peng, 2016), adoptando las innovaciones surgidas al amparo de las tecnologías de la información y la comunicación (Rayport y Svio- kla, 1995) con objeto de ampliar su cartera de productos, incorporando la digitalización de las publicaciones (Rayna y Striukova, 2016). Las empresas de sectores maduros, como el editorial, deben dinamizarse y adaptarse para lograr el éxito competitivo y su desarrollo sostenible ante los cambios del entorno (Morris, 2009; McGrath, 2010; Cavalcante *et al.*, 2011), por lo que, tratar el enfoque de la innovación en el modelo de negocio implica relacionar ambos conceptos en el marco de la economía actual (Afuah y Tucci, 2002; Zott y Amit, 2007).

Es importante destacar el papel en la organización de una cultura innovadora abierta (Chesbrough, 2003). De este modo, en la economía del conocimiento, las empresas podrán identificar nuevas oportunidades de negocio dentro de sus propias estructuras o en colaboración con organizaciones digitales, que seguirán transformando los sectores maduros -industrias completas- con nuevas ideas, técnicas, productos y servicios, es decir, con nuevas lógicas de creación de valor (Massa y Tucci, 2014). En suma, podrán llevar a cabo la innovación requerida del modelo de negocio correspondiente, como respuesta al

reto estratégico al que se enfrenten, de forma que les permitan desarrollar las ventajas, no solo competitivas, sino adaptativas que el entorno actual demanda (Massa *et al.*, 2017).

La adquisición de nuevo conocimiento

Ser capaz de revisar un modelo de negocio existente, a menudo, depende de la capacidad de producir o absorber nuevo conocimiento (Afuah, 1998).

La innovación en producto puede definirse: a) como nueva tecnología o combinación de tecnologías que lleva a desarrollar nuevos productos o servicios introducidos para responder a un uso externo o a una necesidad de mercado y, por tanto, pueden incrementar o expandir el dominio de la empresa (Utterback y Abernathy, 1975); b) como la creación de nuevos productos o servicios, o en la mejora de las características, prestaciones y calidad de los existentes, o c) como la capacidad de desarrollar nuevos productos y/o tecnologías en anticipación o en respuesta a los requerimientos del cliente (Scannell *et al.*, 2000). Sin embargo, centrarse demasiado en los productos existentes podría difuminar el papel y la importancia de las competencias centrales de la empresa y causar miopía, convirtiéndose en una barrera para el cambio (Levitt, 1960).

Aunque las tecnologías potencialmente disruptivas podrían afectar al modo en que las empresas analizan y evalúan su cartera de productos, es posible que esto no siempre se refleje en sus planes, lo que significa que la disrupción percibida por las organizaciones empresariales no se traduce necesariamente en un factor de importancia estratégica en términos de cómo aquellas trabajan para expandir sus propias bases de conocimiento (Hamel, 2006; Sainio y Puumalainen, 2007), incluso, aunque cualquier discontinuidad que permita que las nuevas tecnologías irrumpen en una industria pueda ofrecer oportunidades para nuevos productos y procesos y, por lo tanto, sea la semilla para nuevos modelos de negocios (Sabatier *et al.*, 2010). Cualquier empresa que se enfrenta a un sistema tecno-económico dinámico tendrá que volver a evaluar su cartera de productos y modelos de negocio (Loebbecke, 2010), y las soluciones elegidas reflejarán su comprensión de cómo se crea el valor y cómo aparece el cliente en el nuevo paradigma.

Las editoriales se ven compelidas a interactuar con otras industrias -principalmente del sector tecnológico- en un contexto de economía de mercado para resolver problemas creados por cambios técnicos o socioculturales (Protogerou *et al.*, 2016). Los fabricantes de hardware y proveedores de servicios de Internet han entrado en la industria del libro y pueden adelantarse a los actores tradicionales de la industria en la creación de nuevos modelos de negocio para el contenido digital (Loebbecke, 2010).

El valor agregado del usuario es probablemente la tendencia más importante de la web 2.0 para las empresas orientadas hacia el contenido (Wirtz *et al.*, 2010). De esta forma, tanto los usuarios pasivos como los activos aportan información que las empresas pueden recopilar, y que pueden utilizar para desarrollar nuevos contenidos (Bechmann y Lomborg, 2013) e identificar nuevas oportunidades de innovación (Nylén y Holmström, 2015).

Digitalización de publicaciones

Internet y la digitalización están afectando a toda la economía, lo que provoca una mayor productividad en las industrias existentes, así como nuevas oportunidades de negocios y mercados que pueden socavar las industrias establecidas tal como las conocemos.

La transición de productos y servicios analógicos a digitales representa desafíos y cambios potencialmente fundamentales para la industria editorial (Donoghue, 2010; Lichtenberg, 2011; Carreiro, 2010).

Las características clave de la publicación digital incluyen la disponibilidad de contenido en varios formatos y modos de visualización que dependen de las preferencias del consumidor (Kleper, 2001). La digitalización de la publicación también tiene potencial para nuevas formas de contenido digital, como textos digitales originales acompañados de comentarios y comentarios contemporáneos (Shatzkin, 2008). Sin embargo, la barrera para publicar contenido ha disminuido drásticamente (Sabatier y Fizelle, 2011), lo que puede conducir a nuevos principios para la producción y distribución de contenido.

Internet ofrece la posibilidad de una gran cantidad de contenido generado por los usuarios (Peng, 2016), lo que puede permitir la distribución de proyectos de desarrollo abierto o de código abierto. Al adaptarse a la digitalización, es crucial que los editores se centren en el cliente (Donoghue, 2010).

Las editoriales no lideran la dinámica actual del proceso evolutivo de la innovación tecnológica (Benghozi y Salvador, 2016). De hecho, los formatos ePub y PDF para el libro electrónico no han sido una elección, sino una imposición a nivel internacional de empresas tecnológicas. Frente a las posibilidades ilimitadas de las innovaciones basadas en las nuevas tecnologías, la industria de la edición de libros se caracteriza por la voluntad de conservar una posición de control sobre las tasas de cambio tecnológico (Øiestad y Bugge, 2014).

En mercados más grandes, tendencias como la autoedición se han vuelto dominantes. Las plataformas de autoedición vinculadas a los sellos editoriales podrían redefinir los límites, hasta ahora establecidos entre escritores y aspirantes a escritores (autores indies) en el mundo del libro. En España, editoriales y cadenas de librerías están apostando por la autoedición como una línea más de su negocio. Bubok fue una plataforma pionera de autoedición *online*. Las grandes editoriales ya están realizando los primeros movimientos en este terreno. El grupo Planeta ha lanzado el Universo de Letras, una nueva plataforma de autoedición profesional que nace para dar servicio a quienes desean cumplir el sueño de ver publicado su libro. Además, funciona como plataforma de observación, por lo que aquellas obras que destaquen por su difusión serán valoradas para su posible publicación bajo aquel sello editorial del Grupo Planeta que mejor se ajuste a las características del título. Algunas cadenas de librerías en España también han apostado por la autoedición, como Casa del Libro, a través de Tagus: una plataforma que permite a los usuarios publicar sus libros de manera independiente, pero ofreciendo las prestaciones y la calidad de una editorial tradicional.

Aunque no todos están de acuerdo en que la digitalización alterará fundamentalmente los modelos de negocio existentes para la publicación. Esto sugiere que los formatos impresos y digitales se desarrollen y trabajen en paralelo, a través de un espectro de modelos de negocio en publicaciones que comprenda: modelos de negocio tradicionales, híbridos y completamente digitales (Martin y Tian, 2016). El sector editorial no tiene claro cuál debe ser el modelo de negocio a seguir en su proceso de digitalización (Donoghue, 2010; Øiestad y Bugge, 2014), pero es consciente de que no será impermeable al mismo y que, por tanto, las formas actuales de editar puedan verse, en el futuro, modificadas (Lichtenberg, 2011). Tradicionalmente, las editoriales han controlado a los autores y han servido como guardianes del mercado, pero con las tecnologías digitales y un acceso más fácil al mercado, el equilibrio de poder entre el editor y el autor también puede enfrentarse nuevas condiciones (McAllister *et al.*, 2002).

Cuando la distribución física se vuelve obsoleta, el mercado mismo puede expandirse y trascender las fronteras nacionales. Se rompe la cadena habitual, se eliminan intermediarios y se facilitan nuevas formas de distribución y comercialización. A pesar de conocer que los cambios tecnológicos y las innovaciones en el mundo del libro están originando cambios significativos, la historia ha demostrado que puede ser muy difícil determinar cuándo es el momento de una reestructuración radical o el reemplazo de los modelos de negocio establecidos (Øiestad & Bugge, 2014).

En el contexto español, hay que señalar el nivel de desarrollo del mercado del libro digital muestra una línea similar a la de otros países de su entorno, con la excepción de Reino Unido, país que se sitúa a la cabeza por detrás de Estados Unidos. Desde 2005 el número de ISBNs de publicaciones digitales no han parado de crecer. En el año 2017 se publicaron en España 28433 títulos en formato electrónico. Aunque las ventas de libros electrónicos crecieron un 52% en 2017 en España la facturación generada no supone más del 5% de la facturación total de las empresas editoriales. Las ventas se canalizan mayoritariamente a través de plataformas y distribuidoras digitales, como Amazon, Casa del Libro, Google o Apple Store, entre otras, que concentran el 78,5% de la facturación. Actualmente, en España uno de cada cuatro libros leídos, es en formato digital. En 2017 el índice de lectura digital se situó en el 27% según el Barómetro de Hábitos de Lectura y Compra de Libros 2017, de la Federación de Gremio de Editores de España (FGEE) y la Secretaría de Estado de Cultura.

Método

La metodología empleada para realizar el estudio empírico es el método del caso. La recopilación de datos para el presente estudio de caso se apoya en dieciocho entrevistas semiestructuradas con encuestados de la industria editorial española. La asistencia a ferias y encuentros del sector editorial proporciona un elemento adicional de la recopilación de datos. Las entrevistas personales e individualizadas realizadas en este estudio se llevaron a cabo presencialmente -bien con una presencia física o bien a través de Skype- con cada uno de los responsables de las empresas estudiadas. Las entrevistas se realizaron a responsables de editoriales españolas de distintos tamaños

pequeñas, medianas y grandes. Técnicamente, las entrevistas se desarrollaron sobre unos guiones diseñados por los investigadores, que sirvieron para controlar el desarrollo de las mismas. Sin embargo, se permitió en todo momento que cada responsable entrevistado se expresara con libertad y abiertamente sobre cada punto planteado. De este modo, estos pudieron facilitar información, que, en un principio, no estaba contemplada en el guion, pero que podría aportar datos que pudieran ser utilidad para la investigación. Aproximadamente las entrevistas con los encuestados en las editoriales tuvieron una duración media de una hora. Todos los encuestados ocuparon posiciones que les permitieron hablar sobre estrategias digitales. La recopilación de datos tuvo lugar en el período de enero de 2017 a octubre de 2017.

Los datos de la entrevista se analizaron mediante el proceso de reducción de datos, visualización de datos y elaboración y verificación de las conclusiones (Miles y Hubermans, 1994). Después de cada entrevista, los hallazgos comparativos se ingresaron en una descripción general categorizada. Además, se elaboró un resumen de cada entrevista, sintetizando las impresiones generales de la empresa, basadas en el lenguaje utilizado y las ideas presentadas por los encuestados (Gerring y Cojocar, 2016; Rapley, 2016).

También en las entrevistas se incluyeron a otros entrevistados relacionados con las librerías, con grupos asociativos del sector, con responsables de empresas de distribución de libros, así como, responsables de plataformas que permiten la distribución de ebooks. Además de crear una base más sólida para la discusión, estos actores ayudaron a controlar el sesgo y proporcionaron puntos de vista alternativos. Finalmente, la investigación de escritorio, como los informes de la industria, las estadísticas y evaluaciones de la industria, los artículos de periódicos y otro material disponible en la web, forman parte de los antecedentes y el contexto del presente estudio.

Un estudio de casos: digitalización de editoriales españolas según tamaño

Esta sección presenta el estudio de casos sobre la digitalización de tres editoriales españolas según su tamaño. Antes de continuar para analizar el estudio de caso con más detalle, se presentan algunos antecedentes generales y características de la industria editorial, y características únicas de la industria editorial española.

Habilidades y roles en la industria editorial

Tradicionalmente, el papel del editor de libros ha sido supervisar la producción de libros, desde manuscritos hasta productos impresos. Por lo tanto, las competencias básicas a menudo se centran en la preparación de contenido, en experiencia editorial y curatorial, gestión de derechos, marketing (para títulos generales) y pedagogía (para educación). En el caso de las publicaciones objetivas, el editor también ha actuado como un validador o verificador de datos. La industria editorial se compone de una amplia gama de actores, roles y funciones. El papel del editor ha sido tradicionalmente seleccionar los manuscritos que se desarrollarán y publicarán, además de desarrollar el texto en estrecha colaboración con el autor. Una amplia gama de

actores trabaja con el editor, incluidos los equipos de marketing y ventas, los correctores, los maquetadores y diseñadores. En definitiva, el punto de partida de la producción editorial es la entrega del original por parte del autor a la editorial. La producción editorial comprende varias etapas diferentes y complementarias, que coordina el editor, al cual le corresponde, aparte del seguimiento económico y temporal del proyecto, el dictado y vigilancia de las normas de trabajo.

Una forma de compensar este riesgo es aumentar el volumen de ventas, y se ha creado una industria global del libro basada en la gestión de derechos para respaldar esto. El editor de origen (en el escenario más simple) posee todos los derechos de autor de un proyecto y vende estos derechos a los editores que trabajan en otras regiones o idiomas. En España las traducciones de obras de otros países suponen el 16,1 % de la producción total, por ejemplo, en el año 2016 se ha registrado un aumento del 7,8 % del número de títulos traducidos respecto a 2015. Por otra parte, la venta de derechos editoriales españoles en el extranjero está adquiriendo un papel importante en la estrategia de internacionalización de la industria del libro español.

El contexto español

Hoy en día, gracias a las nuevas tecnologías y a la posibilidad de subcontratar servicios y procesos industriales, la opción de publicar un libro se hace cada vez más factible. Traducido en términos económicos, las barreras de entrada al sector son menores. Esto ha implicado que se produzca una mayor diversificación de la oferta, creándose nuevas empresas editoriales y facilitando la autopublicación. Por ejemplo, en 1996, las pequeñas editoriales representaban el 37% del total de empresas editoriales, mientras que, dos décadas después, suponen el 75% del total. Del total de la producción solo 13 editoriales sobrepasaron la edición de los 700 libros al año.

En estos momentos, se está dando la siguiente paradoja: por una parte, se conforman grandes estructuras editoriales, a través de fusiones y adquisiciones y, por otro lado, surgen iniciativas de pequeño tamaño, dando lugar a una atomización de la estructura del sector en nuestro país. El fenómeno de adquisiciones comenzó en nuestro país en la década de los ochenta con la compra que hizo Bertelsmann de Plaza y Janés en 1984 o la adquisición de la histórica Grijalbo por la italiana Mondadori. El proceso, sin embargo, se ha acelerado en los últimos años, en parte, por dos razones: a) la falta de nuevas generaciones que se hagan cargo de sellos independientes; y b) los problemas financieros de muchos de ellos. En España, la editorial Tusquets pasó a formar parte de Planeta en 2012 y en 2015 se hizo efectiva la fusión de Anagrama con Feltrinelli, fruto de un acuerdo firmado en diciembre de 2010.

La digitalización a nivel de empresa

La siguiente sección describe cómo las diferentes editoriales han cumplido con los nuevos desafíos y oportunidades asociados con la digitalización. Existen claras diferencias entre las empresas editoriales sobre cómo responden a la digitalización. Como el establecimiento de productos y servicios digitales específicos de la empresa está

estrechamente relacionado con la gestión estratégica, estas diferencias se pueden atribuir a las estrategias de largo plazo de las editoriales y de la ruta marcada.

Editorial E1

La editorial E1 tiene una antigüedad de 58 años. Nacida en 1959, adopta la forma de sociedad anónima. Desde sus inicios, se especializó en publicaciones educativas. En la década de los setenta y ochenta añade nuevas colecciones que se desmarcan del ámbito del libro escolar, lo que posteriormente le llevará a crear nuevos sellos editoriales y adquirir otros existentes. En 1988 se aglutinan las distintas editoriales y empresas que han ido surgiendo a lo largo de casi tres décadas de vida de la empresa E1, constituyéndose finalmente como un grupo editorial. Un año más tarde, sale al mercado de valores, siendo, así, el primer grupo editorial español que cotiza en bolsa, con presencia en Latinoamérica. Tiene delegaciones en buena parte del territorio nacional. En la actualidad el Grupo E1 se proyecta como un importante proveedor de contenidos que opera en los campos de la educación, la cultura, el ámbito profesional, el ocio y el entretenimiento. Desde hace quince años se encuentra integrado en un grupo de empresas europeo. La editorial E1 edita tanto libro en papel como libro electrónico. En este último caso, se comenzó editando en formato PDF, pero en el último año todo se hace prácticamente en *ePub*, aunque depende de la plataforma donde se comercialice. Publica más de 1500 títulos al año, estos incluyen ficción nacional y traducida, literatura infantil y juvenil, materiales de enseñanza para escuelas y educación superior, así como revistas, entre otros.

Editorial E2

La editorial E2 tiene una antigüedad de 25 años. Constituida en 1992, adopta la forma de sociedad limitada. Desde sus inicios ha mantenido un sólido crecimiento, basado en su consistente catálogo, que abarca varias colecciones, tanto de ficción como de no ficción. Dentro de las líneas de edición de E2 hay una gran variedad de temáticas y colecciones, que van desde la narrativa y el género negro a la novela histórica en ficción. En no ficción el abanico se abre ampliamente en colecciones, como pensamiento político, biografías, matemáticas, divulgación científica, sociedad actual, informática e historia, entre otras. Aunque la mayor parte de su catálogo lo componen obras en castellano, también ha publicado en catalán, inglés, francés y árabe. Ubicada en un polígono industrial, a 8 kilómetros de distancia del centro urbano, donde tiene las oficinas centrales y los almacenes, cuenta, además, con filiales en el Norte de África y en Latinoamérica. La empresa E2 tiene participaciones en cuatro editoriales, una distribuidora y un canal de televisión digital. Publica más de 600 títulos al año, estos incluyen ficción nacional y traducida, literatura infantil y juvenil, materiales de enseñanza para educación superior, así como revistas, entre otros.

Editorial E3

La editorial E3 tiene una antigüedad de 21 años. Constituida en 1996, adopta la forma de sociedad de responsabilidad limitada. Desde sus inicios mantiene dos sellos editoriales dentro de la misma

organización y dirección editorial. Uno de los sellos agrupa colecciones muy diversas, entre las que destacan las guías de naturaleza y las de patrimonio artístico, muy valoradas por el rigor del contenido, así como por el material gráfico de calidad que las componen-. Es también destacable la colección dedicada a la literatura de viajes, así como las dedicadas a publicar estudios de investigación avanzada en los ámbitos de la literatura española e hispanoamericana. Desde hace más de diez años, se ha decantado por la poesía, editando poemarios y antologías de nombres indispensables del género en castellano y en otros idiomas -en ediciones bilingües con cuidadas traducciones y el texto en la lengua original-. Publica más de 100 títulos al año, estos incluyen ensayo, biografía, pensamiento, narrativa, cuento y relato, entre otros. La editorial E3 edita tanto libro en papel como electrónico, aunque hace una apuesta clara por el libro como objeto y para ello cuida la edición en todos sus detalles: formato, tipografía, encuadernación, así como las imágenes de la portada, que, en la mayoría de los casos, son de autor y realizadas *ex profeso* para cada título. Tiene todo su fondo digitalizado, pero solo comercializa una parte del mismo a través de plataformas digitales.

Discusión de hallazgos

Esta sección proporciona respuestas a la pregunta de investigación planteada al comienzo del documento: ¿cómo afecta la digitalización a los modelos de negocio en la industria editorial de libros? ¿Cómo adquieren los editores nuevos conocimientos para adaptarse a la era digital? ¿En qué medida las políticas culturales y las estructuras de propiedad, influyen en la digitalización de la industria del libro? En la siguiente sección, sintetizaremos y discutiremos los hallazgos de los dos niveles, y los relacionaremos con los modelos de negocio, desarrollo de competencias e instituciones.

Adaptación de tecnologías digitales a modelos de negocio existentes

Las editoriales estudiadas, por un lado, han dado los primeros pasos en la exploración de nuevos productos digitales y han avanzado relativamente poco en el desarrollo de infraestructuras digitales interoperables, estándares industriales y sistemas de distribución conjunta. Todavía tienen mucho camino por recorrer antes de que puedan aprovechar plenamente el potencial de las nuevas tecnologías digitales a través de modelos de negocio y estructuras de ventas revisados.

La calidad y la complejidad de las herramientas de enseñanza digital han contribuido a los desarrollos en el mercado educativo más allá de la literatura general y su formato ePub basado en texto, donde las tendencias globalizadas imponen un enfoque en el precio y la distribución. Esta divergencia ha llevado a la falta de un diseño dominante y un canal de ventas dominante, lo que deja a la industria editorial con una considerable incertidumbre con respecto a sus estrategias digitales a largo plazo. La situación es en parte un reflejo de los objetivos divergentes establecidos por los editores, los formatos digitales divergentes y la divergencia de los mercados generales y educativos. La inseguridad causada por la falta de un diseño dominante ha hecho que hasta ahora los editores experimenten con nuevas tecnologías digitales basadas en modelos de negocio existentes. La plena realización de nuevos modelos de negocios depende de la estabilización del desarrollo digital.

A pesar de que en la edición del libro digital se suprime la impresión, hay que tener en cuenta los nuevos procesos propios de las nuevas tecnologías y de la elaboración del *ebook*, como la creación de ficheros XMLs y la estructuración de formatos integrando los metadatos. Los formatos actuales tienen etiquetas de metadatos, que permiten almacenar la información, como el autor, la editorial, el año, la edición. El formato elegido deberá ser compatible con la plataforma en la que se vaya a distribuir el *ebook*. Las diferencias significativas entre los *ebooks* en formato PDF y aquellos en formato *ePub* son evidentes a la hora de integrar elementos interactivos.

En un intento por tener control sobre su contenido, los editores han recurrido al DRM. Sin embargo, los controles DRM actualmente no están estandarizados, no son suficientemente accesibles y resultan demasiado caros para la mayoría de los editores. Son muchos los autores y editores que desconfían y se muestran reacios al desarrollo de contenidos digitalizados hasta que la tecnología pueda proporcionar protecciones adecuadas frente a la piratería. De hecho, los editores temen tanto a la piratería digital, que están insistiendo en un nivel de DRM que provoca severas restricciones sobre cómo pueden usar los lectores los libros que se compran. En suma, la resistencia de los editores a dar a los usuarios los mismos derechos que tendrían con los libros impresos ha demostrado ser una limitación significativa en el crecimiento de los libros electrónicos.

Los editores todavía están anclados en los modelos de negocio existentes y las redes de distribución tradicionales, y están explorando las nuevas oportunidades en la publicación en línea paso a paso. Muchas de las iniciativas digitales en las tres editoriales estudiadas siguen siendo limitadas y fragmentadas en términos de organización interna. Los editores han demostrado ser receptivos, pero no proactivos, en la digitalización. Se puede decir que los editores españoles están actualmente aplicando una combinación de todos los modelos de negocio; es decir, 'ladrillos y mortero', 'clics y mortero', colaborativo y freemium. No obstante, el modelo tradicional de "ladrillos y mortero" sigue siendo claramente dominante. Este patrón está en línea con las teorías que enfatizan cómo el desarrollo de un conjunto de modelos de negocio paralelos (Smith *et al.*, 2010) o una cartera de modelos de negocio (Sabatier *et al.*, 2010) pueden ser una forma de revisar gradualmente los modelos existentes.

A pesar de esto, hay motivos para preguntarse en qué medida la exploración de nuevos modelos de negocios se ha reflejado en una gestión correspondiente del aprendizaje y desarrollo de nuevas competencias. En la siguiente sección, discutiremos y problematizaremos cómo los estudios de casos han revelado una insuficiente adaptación a las expectativas de la demanda privada y que las instituciones preservan el paradigma de publicación analógica.

Insuficiente adaptación a las expectativas de la demanda privada

Los editores en este estudio han encontrado que los usuarios tienen diferentes expectativas de los productos digitales en comparación con sus predecesores analógicos. Si bien el libro en papel se revisa y reimprime a intervalos regulares, se espera que los productos

digitales tengan actualizaciones frecuentes, desarrollos constantes y posibilidades de personalización. Para responder a esta presión (de transformación) creada por el usuario es común, en las industrias de software y servicios, utilizar la creación interactiva de productos. Las empresas establecen las funcionalidades básicas del producto en un primer momento y, posteriormente, utilizan los comentarios de los usuarios para crear y desarrollar el producto a lo largo del tiempo. Esto crea un entorno de actualizaciones constantes y contacto directo con el cliente. Algunos editores están implementando este nuevo flujo de trabajo para sus proyectos digitales más grandes, pero estos siguen siendo la excepción que confirma la regla.

Instituciones que preservan el paradigma de publicación analógica

La forma en que los editores se relacionan con las tecnologías digitales y sus propios modelos de negocio también se pueden entender en relación con las políticas públicas que rodean a la industria. El sistema fiscal tal como existe hoy constituye un fortalecimiento del régimen de publicación analógica que puede obstaculizar el desarrollo de negocios basado en tecnologías digitales. A diferencia de los libros impresos que tributan a un 4%, los libros electrónicos están sujetos en España a un IVA del 21%. Por otra parte, no existe una solución clara de las compras públicas de libros electrónicos para las bibliotecas: dependiendo de la plataforma que gane el concurso público, las bibliotecas podrán tener acceso a unos determinados títulos y otros no. Tampoco existe un plan de apoyo financiero o de ayudas públicas para el desarrollo de contenido digital por parte de las editoriales.

En conclusión, las políticas culturales y las estructuras de propiedad están sesgadas hacia la salvaguarda de los ingresos y la estabilidad económica del régimen de publicación analógica y hacia sus modelos de negocios asociados, limitando considerablemente la digitalización de contenidos.

Implicaciones para el desarrollo empresarial en la era digital

Aunque el comportamiento observado entre las editoriales españolas es comprensible y acorde con la teoría analizada, es necesario preguntarse de qué manera las iniciativas digitales emprendidas por los editores españoles afectarán a su futuro desarrollo empresarial.

A diferencia de lo que ocurre en otros contextos analizados por la literatura académica (Øiestad & Bugge, 2014), la estrategia desarrollada por la industria editorial en torno a su transformación digital no se ha movido hacia la construcción de barreras de entrada para competidores externos. Y quizá sea esa apertura del mercado lo que pueda facilitar una mejor y más rápida asimilación de las innovaciones disruptivas en las empresas de la industria editorial española.

Conclusiones finales

Las editoriales analizadas han ido adquiriendo conocimientos digitales y han intentado posicionarse para poder responder a los cambios del mercado y las tecnologías cambiantes, pero los productos y servicios digitales aún se consideran secundarios al libro analógico. De hecho, los sistemas de distribución desarrollados en torno al libro electrónico replican la cadena tradicional del libro en papel.

Por otra parte, la proporción de títulos disponibles en formatos digitales sigue siendo reducida, lo que se explica, no por el lado de la demanda, sino por el lado de la oferta. En este sentido, las explicaciones derivadas del análisis conducen a que las editoriales estudiadas argumenten, como causa de lo anterior: a) falta de recursos que limita la edición digital, b) cierta aversión al riesgo que las apunala en el modelo de negocio tradicional predominante del papel, c) elevada incertidumbre asociada a los aspectos técnicos (formatos y procesos dominantes), y d) falta de apoyo institucional que estimule su transición digital y la redefinición de sus respectivos modelos de negocio. Por el momento, los editores estudiados simplemente están vendiendo versiones digitales de sus libros en papel en las plataformas de distribución digital, en un intento de minimizar riesgos al apostar por obras contrastadas positivamente en el modelo de negocio tradicional. Esta decisión estratégica conduce, al menos en el corto plazo, a que sean las empresas tecnológicas con suficientes recursos financieros y conocimientos especializados quienes controlen la distribución y venta del libro digital.

La falta de iniciativas digitales conjuntas está provocando que nuevos actores ajenos al sector como los fabricantes de *hardware* y proveedores de servicios de Internet hayan entrado en la industria del libro y puedan superar a los actores tradicionales de la industria en la creación de nuevos modelos de negocio para el contenido digital. Por ejemplo, la aparición de nuevos jugadores, como Amazon en el *retailing*, ha golpeado la rentabilidad de las librerías, además de reducir la necesidad de utilizar, por parte de las empresas editoriales, distribuidores.

Esta estrategia del modelo de negocio observado entre las editoriales estudiadas es comprensible y está en línea con la teoría expuesta en el presente estudio. También demuestra cómo se comportan las empresas cuando quieren mantener una posición de control con respecto a las tasas de cambio tecnológico. Los editores analizados consideran que el libro electrónico viene a complementar al libro en papel: no lo ven como un sustitutivo de éste.

Las editoriales consideran que han asumido ya tantos riesgos comerciales y estéticos al crear nuevos contenidos que no pueden afrontar riesgos técnicos adicionales. Como consecuencia, son reacios a invertir directamente en proyectos de I+D y prefieren adoptar soluciones técnicas contrastadas. Este proceso podría originar una dependencia involuntaria de las innovaciones externas que determinen la evolución real del sector.

Finalmente, de todo este estudio cabe plantearse la necesidad de que las editoriales no deban limitarse a realizar un simple cambio de formato de libro (del papel al electrónico): deberían impulsar el desarrollo de todas aquellas posibilidades que las nuevas tecnologías puedan ofrecer, liderando la transición digital en la industria del libro.

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A Systematic Review of the Debate and the Researchers of Disruptive Innovation

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Abstract: Despite the popularity of the term “disruptive innovation”, its applications have taken on different meanings. Clayton Christensen is a prominent author in the field but his approach has not been applied in a consistent manner. To elucidate the use of the term in business studies, this paper employs a bibliometric approach to provide a descriptive analysis of researchers and their relevant works in the network formed by the related literature, in addition to distinguishing and grouping associated authors. The results suggest a dissimilarity of objectives between two sub-groups using the term “disruptive innovation”, and the discussion about Clayton Christensen’s specific meaning of the term seems to make sense to only one of them.

Keywords: disruptive innovation; disruptive technology; innovation; disruption

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Introduction

The terms “disruptive innovation” and “disruptive technology” have gained prominence in recent years, with academic interest evidenced by special editions of reputed journals dedicated to the theme of disruption, such as the Journal of Management Studies, Journal of Product Innovation Management, IEEE Transactions on Engineering Management and Technological Forecasting and Social Change, as well as by the terms’ inclusion in management and innovation textbooks (e.g., Garud, Kumaraswamy & Langlois, 2003; Besanko, Dranove, & Shanley, 2004; Trott, 2008; and Hill, Jones, & Schilling, 2015). The terms are usually associated with Clayton Christensen, whose academic papers obtained high citation grades and whose books achieved great commercial success. In 2011, The Economist magazine included Christensen’s 1997 book, *The Innovator’s Dilemma*, among the six classics in management literature of the past fifty years.

Despite Christensen’s accomplishments, the concept of disruptive innovation generated well-known controversies in the field of management studies (Hopp, Antons, Kaminski, & Salge, 2018a). An innovation that causes disruption in a market is not necessarily a disruptive innovation as Christensen defines it (Schmidt & Druehl, 2008). If, on the one hand, media success or sales figures do not necessarily represent the truth about the development of Christensen’s work, then some criticisms seem extreme, in terms of both the theoretical quality of his work and the originality of his contribution. The debate over the validity of Christensen’s approach has been intense over the past decade, with exalted condemnations or nonconsensual modifications of the theory by some authors (e.g., Markides, 2006; Daneels, 2004; Markides, 2013; and King & Baatartogtokh, 2015). Above all, the discussions manifest the existence of a dispute in this field of knowledge.

An important and possibly related fact about some of the criticisms is that, even with the frequent use of the term, the theory’s concepts are not always applied in a consistent manner. It is not unusual for the expression “disruptive innovation” to be employed with a

radical meaning that is distant from what was intended by Christensen. According to the Organization for Economic Cooperation and Development (OECD), for example, disruptive innovation “has a significant impact on a market and on the economic activity of firms in that market. This concept focuses on the impact of the innovations, as opposed to their novelty” (OECD, 2005, p.58). Famous examples such as Uber, which has already caused significant changes in the taxi industries of several cities around the world and is frequently referred to as a disruptive innovation, does not fit into the concept proposed by the theory’s authors (Christensen, Raynor, & McDonald, 2015). In another example of imprecise use, Souza and Takahashi (2012) disregarded the possibility of new market disruption when they stated that “the evolutionary trajectory of the performance of a disruptive innovation makes it eventually competitive in the main market (otherwise it is not a disruptive innovation)” (our translation, parentheses in the original, p.123). The authors reduce the predictive qualities of the approach when they suggest that the theory can only be explained *ex post facto*.

Semantic confusion is undesirable in scientific postulates. The conflict over the use of “disruptive innovation” in academic evaluations can reduce the relevant by-products from research and, consequently, the contributions to managers and their organizations. Hence, efforts to reduce asymmetries in terminological understanding are welcome. In English, where the word “disruption” already belongs to the language, the confusion between Christensen’s sense and its popular meaning is apparent and raises heated discussions among some authors. In other languages that do not embrace the word “disruption” as a native term, such as Spanish or Portuguese, the confusion should be less frequent but still manifests itself and, therefore, the correct meaning must be clarified in specialized publications.

Attempts have been made to use bibliometric techniques to better comprehend the development of the field. From what is known, bibliometric analysis was applied with a focus on disruptive innovations in Pilkington (2009); Cândido (2011); Schiavi and Behr (2017);

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Li, Porter, and Suominen (2017) and Hopp, Antons, Kaminski, and Salge (2018b). Pilkington (2009) evaluated three hypotheses related to the impact of Christensen, and showed the authors' stable citations growth over time, eventually expanding to other areas of research beyond the strategy and management of organizations. Cândido (2011) assessed the evolution of the number of papers that contained the term "disruptive innovation" as a keyword, in addition to its geographic and periodical distribution. As a project for a doctoral thesis, the work can be considered less conclusive. Schiavi and Behr (2017) investigated the term "disruptive business model". The analysis is descriptive but comprehensive, beginning with an initial selection of 1,661 articles and examining the 19 most relevant papers published between 2004 and 2016 in detail. The authors verified the preponderance of applied studies in relation to theoretical approaches and suggest more bibliometric analyses as an extension of their study. Li, Porter, and Suominen (2017) analyzed the dichotomy between the concepts of "disruptive technology" or "disruptive innovation" (DT or DI) and "emergent technology" (ET), identified a relationship between DI and ET, and advocated for a harmonized approach to embracing both concepts. Recently, Hopp, Antons, Kaminski, and Salge (2018b) mapped disruption-related papers and concentrated on the 84 most researched topics, analyzing the temporal dynamics of the field and suggesting the consolidation of peripheral or dissociated topics, together with the conciliation of terminologies.

Differently from the cited papers, this review focuses on the discussion between "disruptive innovations" as defined by Christensen and all other types of innovation that, even if not adherent to Christensen's concept, were named "disruptive innovation". We aim to analyze the literature that applies the term and identify differences and similarities between authors and related papers. A bibliometric approach is applied for the analysis of the delineated universe and helps to evaluate the prominence of Christensen in the selection, in addition to distinguishing and grouping authors associated with other connotations of the term.

Evolution of the innovation debate

The origin of studies on innovation with an explicit focus on organizations is not entirely clear, with specific contributions coming from different areas. From a wider perspective, if one looks at improvements in productivity achieved through the use of machines and new processes as innovations, the discussion has been going on since the time of Adam Smith. In his classic *The Wealth of Nations* ([1776] 2007), Smith characterized the division of labor as a facilitator of machine inventions, which expanded productivity and production and allowed greater economic development of contemporary societies. In recent times, Schumpeter (1912) emphasized the importance of entrepreneurial activities for technological development and consequent economic growth. The author's work is considered to be an important reference in many studies directed at organizations. Schumpeter's ([1942] 2014) vision of the innovative process evolved throughout his career, culminating in the recognition that resources, processes, and routines available to large corporations in concentrated markets provide advantages for these companies to innovate.

Over the years, more refined constructs have been developed for the benefit of both countries and organizations.

Among the first studies to mark the contemporary view of innovation from an organizational perspective are Utterback and Abernathy (1975) and Abernathy and Utterback (1978), which extended the analyses beyond cases of an incremental nature that occur with knowledge accumulation in established firms. The authors describe radical innovations as those associated with the recognition of new demand and the introduction of superior performance, without solely seeking to reduce costs with standard technologies. Such innovations would create recognized competitive advantages over the existing supply (Porter, 1985). In recent decades, innovations have come to be evaluated based on other dimensions, incorporating not only a technological aspect but also demand types (Abernathy & Clark, 1985; Christensen, 1997) and a system facet (Henderson & Clark, 1990). In the past, the one-dimensional view of innovation left gaps while explaining the progress of some technologies and organizations; therefore, it seems that more sophisticated models are required.

Christensen's Disruptive Innovation

The theory of disruptive innovation was developed in the 1990s by Clayton Christensen while pursuing his Doctorate in Business Management from the Harvard Business School and emerged as an attempt to shed light on why companies failed to identify that some innovations with less embedded technology threatened their dominant positions. This anomaly was articulated by Christensen and his colleagues (e.g., Bower & Christensen, 1995; Christensen & Bower, 1996; Christensen, 1997; Christensen & Overdorf, 2000; Christensen & Raynor, 2003; Christensen, Anthony, & Roth, 2004) with important managerial lessons, including that paying exclusive attention to the best customers and the current values in an established company would increasingly disengage it from disruptive innovations and could jeopardize its future growth.

For Christensen, Anthony, and Roth (2004), disruptive innovations "either create new markets, bring new attractiveness to nonconsumers, or offer more convenience, at lower prices, to lower-income consumers in an existing market" (p.321). Additionally, domination by a new entrant in a breakthrough movement in an established market may occur, but it is not necessary to characterize an innovation as disruptive in Christensen's sense.

According to Christensen's theory, firms that innovate in a radical or incremental manner in a struggle to improve their overall quality in order to further improve their products, usually pursue the attributes of a dominant design. Such firms practice so-called "sustaining innovations" and compete to serve a class of unsatisfied consumers who would pay more for improvements in features or attributes of the product consumed. This group should comprise the majority of firms and innovations. On the other hand, there are companies that seek to serve satisfied consumers and accept or desire a lower quality or quantity of certain attributes. Such companies practice low-end disruptive strategies. As an example, Christensen (1997) presents 3½-

inch floppy disk readers as low-end innovators over their 5¼-inch competitors in the 1980s. Until that date, although the 3½ disks were smaller than the dominant 5¼ disks, they did not meet the storage capacity required by leading minicomputer and PC makers and were thus produced by companies that served a limited and less profitable market comprised of the nascent laptop industry. Over time, through incremental innovations, the 3½ floppy disks met the standard storage capacity required by the minicomputer and PC market, capturing a significant portion of the market from its 5¼ competitors. A similar pattern was found in the previous period:

For example, the 8-inch floppy disk would store 20 MB when it was first introduced, while the primary floppy disk market at that time was mainframe and required 200 MB disk. Not surprisingly, leading computer producers rejected the architecture of the 8-inch floppy disk initially. As a result, vendors, whose mainstream products consisted of 14-inch disks with more than 200 MB of capacity, did not aggressively track disruptive products. (Bower & Christensen, 1995, p.45)

Finally, Christensen's theory states that there are innovations that bring new consumers to the market, previously untapped due to lack of ability to consume or enjoy the good (or service) or insufficient resources. By making products and services simpler and cheaper, firms enable the emergence of consumers requesting attributes that are different from those demanded by the conventional market. Firms that practice such strategies are called new-market disruptive innovators. The Sony Walkman is a typical example (Christensen, 1997), as it personalized music to people who walked or jogged and had no option available except for portable radio alternatives. More recently, Kenya's Vodafone-Safaricom M-Pesa provided another example of a new-market disruptive innovation when it started offering Short Message Service (SMS) payment services at a time when more sophisticated and faster technologies were available but did not reach a significant portion of potential consumers (Ngugi, Pelowski, & Ogembo, 2010).

Figure 1. Model of the Disruptive Innovation Theory developed by Christensen, Anthony, and Roth (2004)

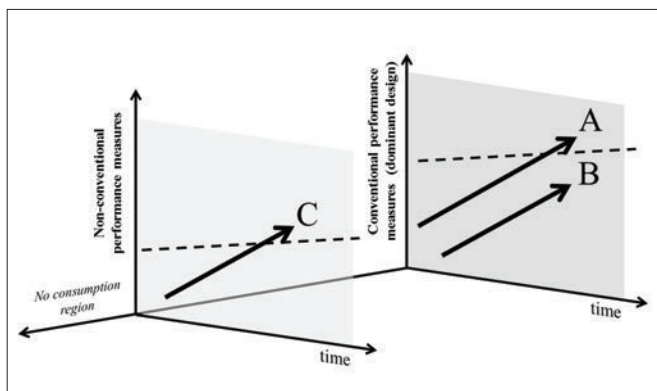


Figure 1 summarizes the essential elements of Christensen's theoretical model. The dotted lines are the evolutionary trajectories of the attributes demanded by the average consumer, and the thick arrows represent the technological evolution of different companies.

Company A is one that seeks to increase the supply of attributes valued by its current customers, and its innovations are called sustainable. Company B, on the other hand, innovates by reducing the number of attributes in its products (low-end disruptive innovation) and potentially, but not necessarily, achieves this goal in the future. Finally, company C captures nonconsumers, who place more value on a different set of attributes than the design favored by dominant consumers (new-market disruptive innovation).

Christensen argues that his approach is subject to fewer observable anomalies than previous theoretical constructs, especially with the incorporation of its most recent advances. In Christensen (2006), for example, the scope of the theory has been expanded and it now considers changes in business models as innovation, preferring the term "disruptive innovation" to the previous "disruptive technology". Since the second edition of his book, *The Innovator's Dilemma*, in the year 2000, Christensen has pointed out that resources, processes, and values would delineate an organization's innovative possibilities by building up relevant knowledge applicable to firms threatened by disruptors.

Criticism of Christensen's approach

Christensen's (1997) approach provided an important theoretical advance. It added constructs and filled gaps left by previous theories of innovation. Even critical authors recognize the virtues of the approach and suggest that we do not abandon it (e.g., King & Baatar-togtokh, 2015). However, similar to any theoretical construction, it does not evolve without criticism.

Henderson (2006), for example, exposes the fact that the theory is based on the cognitive failures of agents who do not identify disruptive opportunities within the spectrum of indicators already consolidated by the dominant design and their current clients. The author argues for the rationality of the leaders of organizations that do not respond to disruptive innovations, given the characteristics of competencies already present in established firms. The decision to serve current customers in the mainstream market, which provides the best profits, rather than pursuing a disruption with a lesser probability of success and lower profitability, would be reasonable and consistent with the empirical data. In reference to disruptive innovations that create or rely on new patterns of market preferences, the author states that it is "particularly difficult for established firms to respond effectively for reasons that are embedded in firm competencies" (2006, p.9).

For Markides (2006), the theory developed by Christensen has been mistakenly used in the analysis of different disruptive innovations. Although Christensen and Raynor (2003) expanded the scope of disruptive innovations beyond the technological context previously outlined in Christensen (1997) to also encompass business model and products, Markides (2006) emphasizes that disruptive innovations may have some effects on competition that must be administered in a manner different than that advocated by Christensen (1997). Markides' argument is that there are different kinds of disruptive innovations and that they should be treated differently. The author explores

two phenomena present in the literature: innovation in business model and radical product innovation. According to Markides, these two types of innovations threaten unprepared firms in a manner similar to Christensen's (1997) description, but inhibiting excessive proximity to customers, as suggested by Bower and Christensen (1995), would not be the most appropriate approach to innovations that were not purely technological.

While some authors argue that upmarket innovations that improve the quality of a product or service may be disruptive innovations (Markides, 2006), Christensen, Raynor, and McDonald (2015) reject this idea and reiterate that disruptive innovations are exclusively low-end or new market innovations. Improving what is already being offered to the mainstream market is not a disruptive innovation in Christensen's sense, but rather is a sustaining innovation.

Bibliometric analysis

The evaluation begins with the selection of articles in the Web of Science database from 1995 to 2017 that have the terms "disrupt* innovat*" or "disrupt* technolog*" in their titles, abstracts or keywords. This method generated 876 papers and 2,299 authors, amounting to 11,941 citations, excluding self-citations. Because the set of articles was also filtered based on the category of interest, (e.g., Business & Economics), the selection was restricted to 333 publications by 675 different authors. As an additional filter, only articles with at least one citation were kept, resulting in a sample of 266 articles in 82 journals by 500 different authors. We restrict the sample further by selecting the ten journals with the highest JCR indices, listed in Table 1, resulting in a universe of analysis consisting of 140 articles.

Table 1. Search filters - Web of Science database

Codes	Filters	# papers	# authors
(A)	Title, abstract or key-word containing "disrupt* innovat*" or "disrupt* technolog*"	876	2.299
(B)	Category: Business & Economics	333	675
(C)	Number of citation > 0	266	500
(D)	Journals: (D1) Technological Forecasting and Social Change; (D2) Journal of Product Innovation Management; (D3) Harvard Business Review; (D4) Technovation; (D5) Research-Technology Management; (D6) Research Policy; (D7) Technology Analysis & Strategic Management; (D8) Creativity and Innovation Management; (D9) International Journal of Technology Management; (D10) IEEE Transactions of Engineering Management.	140	301

The temporal evolution of the publications in the universe of analysis begins in 1995 with Bower and Christensen's (1995) seminal article, *Disruptive Technologies - Catching the wave*, in which the "disruptive innovation" concept was still referred to by the term "disruptive technology". Between 1995 and 1999, there were no articles in the sample. The peak of representation occurred in 2013 with the publication of 17 articles. Table 2 summarizes the distribution of the number of publications in each journal in the research universe.

Table 2. Distribution of the number of articles by periodical and year of publication. Codes (D1) and (D10) follow as in Table 1

Journal	Publication year																			
	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Total
(D1)						4	2		7	3	2	3			5	2	4	5	1	38
(D2)						1			1	2		2	3	1	2	2	1		1	16
(D3)	1	1	1	3		1		1	1	1			1		1		1			13
(D4)				2						1	1	3	2			2	2			13
(D5)			1			1			2		1	1	4	1			1			12
(D6)									1	1				2	2	1	1	3		11
(D7)							1				2			3	3	2				11
(D8)													1	2	3	2		1		9
(D9)					1	2		1		2		1	1	1						9
(D10)				2						1		1		1	1	1		1		8
Total	1	1	2	7	1	9	3	2	12	11	6	11	12	11	17	12	10	10	2	140

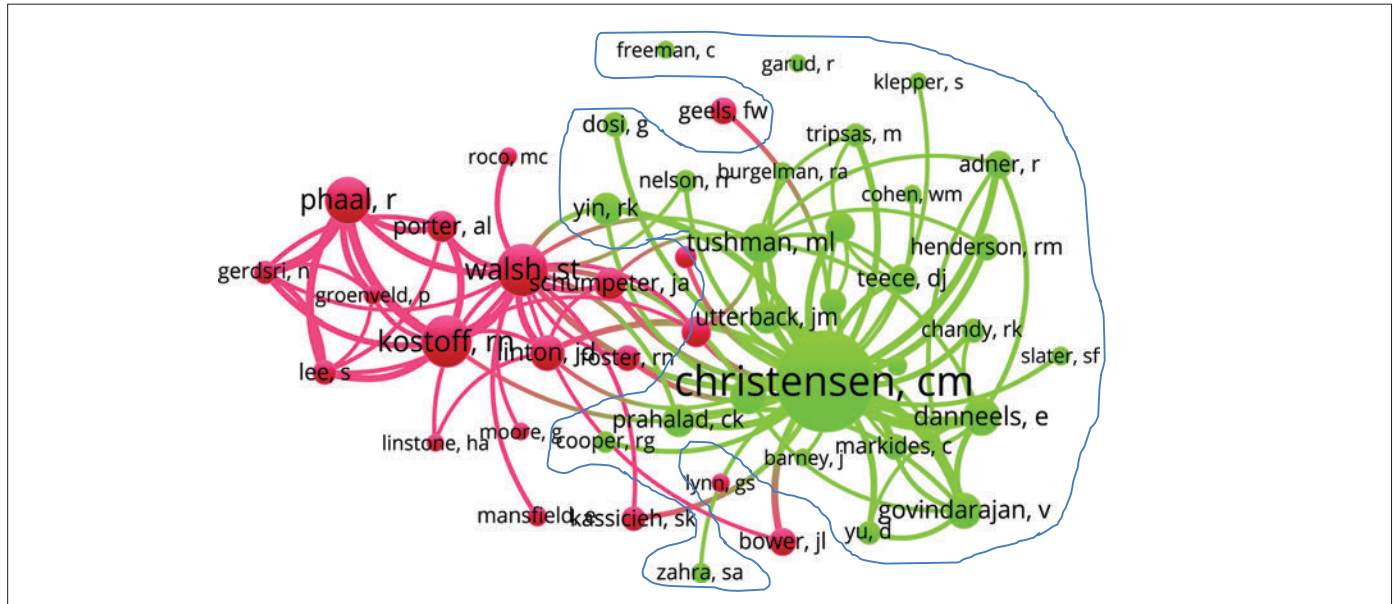
Within this research universe, the core subjects selected were the 25 most cited articles, produced by 55 different authors, and representing more than 75% of the citations in the universe; that is, 3,215 citations out of a total of 4,281 from 140 articles. Then, after this selection

of authors and their co-citations, the metadata were submitted to analysis, carried out with the support of the Bibexcel and Stata software. The set of the 25 articles selected is presented in the appendix.

Assuming that authors can be identified with a single theoretical framework, the analysis of co-citations was made using the authors of the 25 papers selected as units of analysis, resulting in a total of 55 names. Based on these names and those present in the co-citation list, a network was constructed and the

centrality and intermediation grades were calculated. The network is visualized in Figure 2, which was restricted to authors cited at least 300 times in the research universe and has distinct coloration for each of the two groups formed: Group 1 in red and Group 2 in green.

Figure 2. Author co-citation network



The clusters suggest that authors who are critical of some Christensen's ideas, such as Erwin Danneels, or even authors who employ a concept distinct from that proposed by Christensen, such as Michael Tushman, are in the same cluster (Group 2 (green)). On the other hand, Group 1 (red) contemplates authors whose papers focus more on the application of innovation management tools and techniques, such as technological roadmaps, and who rarely discuss

the theoretical aspects common to other areas of investigation. The centrality and intermediation degrees for the authors calculated in the standard and normalized versions are presented in Table 3 and show that Christensen has both high centrality and intermediation, suggesting that the author not only concentrates attention but also aids in the development of the network close to several pairs, even from a different group.

Table 3. Grouping, degrees of centrality and intermediation of main authors

Author	Group	Centrality		Author	Group	Intermediation	
		Standard	Normalized			Standard	Normalized
Christensen C	2	37	0.804	Walsh S	1	419.02	0.202
Bower J	2	36	0.783	Daim T	1	321.00	0.155
Danneels E	2	29	0.630	Lee J	1	315.51	0.152
Baker W	2	25	0.543	Christensen C	2	259.45	0.125
Daim T	1	22	0.478	Kirchhoff B	1	225.85	0.109
Lee C	1	21	0.457	Newbert S	1	178.10	0.086
Lee J	1	21	0.457	Phaal R	1	165.11	0.080
Johnson M	2	21	0.457	Robinson D	1	164.76	0.080
Gassmann O	2	19	0.413	Prusak L	2	151.36	0.073
Lee S	1	19	0.413	Baker W	2	147.35	0.071

Moreover, as this study took the approach of constructing groups by author, it was not possible to glimpse the situation in which the same author has works with distinct characteristics; for example, belonging to different groups. This is the case of Steve Walsh, who possesses the

highest degree of intermediation. As an illustration of his importance, if one ignores the minimum node rule in each cluster, the author emerges at the head of a third cluster. To cover more details about the groups, the analysis continued with a focus on the keywords given by

the original set of 140 articles and the construction of their network. The resulting map is shown in Figure 3, with a cluster-oriented cons-

truction and a minimum of 13 occurrences, chosen ad hoc to improve visual representation of the network.

Figure 3. Keyword occurrence network

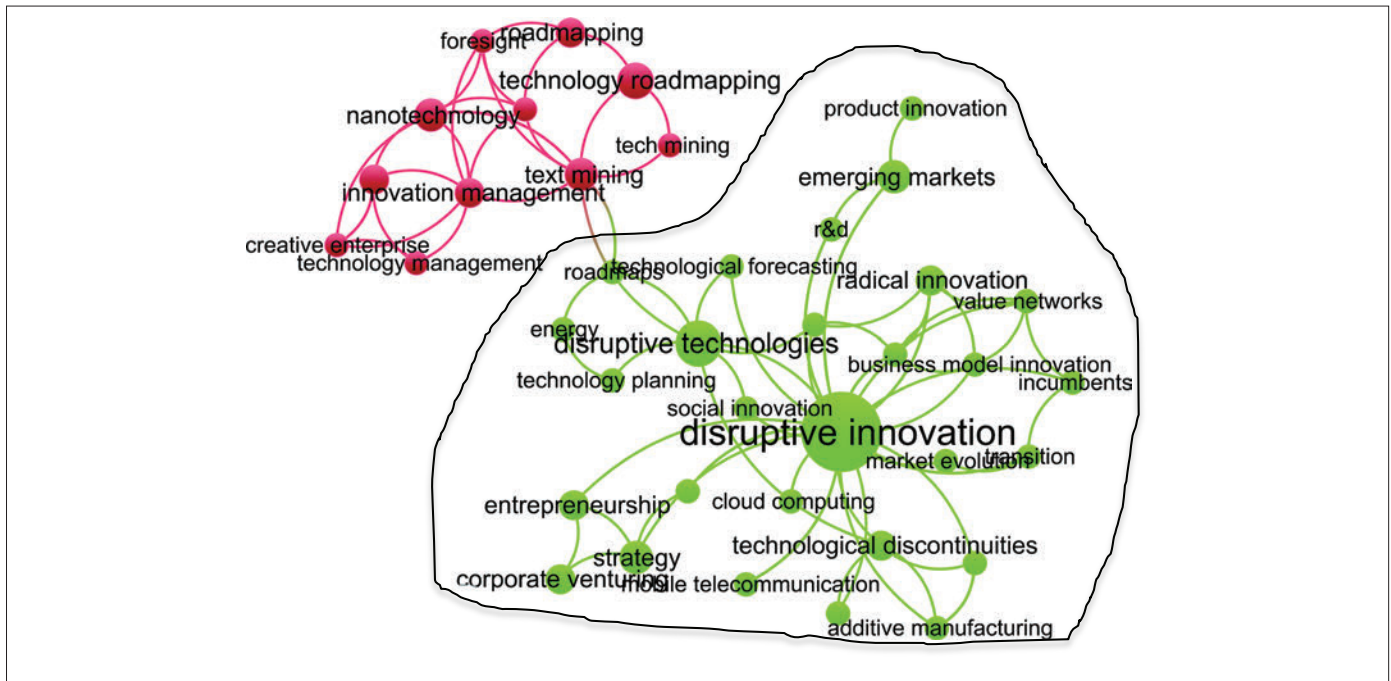


Figure 3 is in line with initial impressions that there is one group (red) which is associated with the development of management tools, such as the technology roadmap and is less concerned with discussing the term “disruptive innovation” or its meaning as suggested by Christensen. Disruptive innovations for this group are those that oppose incremental or architectural innovations and are usually taken as synonyms for radical or breakthrough innovations. This group has been more frequently featured in the journal *Technological Forecasting and Social Change*. On the other hand, the other group (green) exposes different typologies of innovation that are more associated with works that seek theoretical development in

management disciplines, but which are criticized for having a retrospective view. They consist of texts written by Christensen and colleagues but also by authors who discuss or criticize their concepts (e.g., Daneels, 2004; Schmidt & Druehl, 2008). They are part of the business and management community, with major contributions made by the *Harvard Business Review* and the *Journal of Product Innovation Management*.

As a final point, based on the exercise carried out, a composition was constructed with two major thematic groups related to disruptive innovations. This conciliation is presented in Table 4.

Table 4. Group composition of selected articles

Group	Authors	Associated terms	Characteristics
Green	Bower J; Christensen C; Danneels E; Henderson R; Markides C; O'Reilly C; Tushman M; Utterback J;	Creative destruction; Business model innovation; Technological discontinuities; Radical innovation; Incumbents	It seeks to explain and test determinants of innovations; Related to the business and management community. Engages, discusses or tests Christensen's concepts.
Red	Daim T; Kostoff R; Lee S; Linton J; Phaal R; Porter A; Walsh S; Yoon B;	Technology roadmap; Innovation management; Technology planning; Technology entrepreneurship; Tech mining	Employs prediction or similar tools in innovation management; Related to multidisciplinary communities. Do not discuss Christensen's concepts.

The Red subgroup is dedicated to assisting with the monitoring, planning, acquisition or employment of technologies, with a

multidisciplinary focus and strong influence on engineering. Although the use of the term “disruptive innovation” is associated

with radical events, the discussion about the conceptualization given by Christensen is almost nonexistent. The Green subgroup has a greater adherence to the area of business and strategy and presents more enthusiasm for theoretical constructions. It is common for this group to test or discuss the conception of disruptive innovation proposed by Christensen. The authors from this group do not always agree with Christensen's conceptualization, but it is in this group that eventual discussions about the term tend to occur.

Final remarks

The understanding of different types of innovation is relevant to the advancement of theoretical constructs and applications within organizations, an idea that has been accepted at least since Utterback and Abernathy (1975), and disruptive innovations should not be an exception. The present paper tried to map the main authors related to the theme and their respective publications. For readers less familiar with the debate, this enables the selection of important papers to obtain a better understanding of the insertion of Christensen into the research universe. For more experienced practitioners and academics, the work provides a panoramic view of the field associated with disruptive innovation, with an explicit suggestion for further development of the theory in the last paragraph.

Overall, the analysis showed that Christensen's prominence in the debate is evident. Even if a reader considers Christensen's disruptive innovation definition trivial, incomplete, or misleading, his name has acquired distinction in the literature. In addition to his high degree of centrality, he also has one of the highest degrees of intermediation. Although simpler terminology and definitions may be preferred (Hopp et al., 2018b), a semantic narrowing of the term "disruptive innovation" seems to be necessary for the consequent development of innovation theories. The narrowing of the concept has two advantages. Firstly, it provides a clearer path to theoretical improvements. More precise constructs may reduce undesirable ambiguities and help us to better understand how firms cope with disruptive innovations and introduce them. Secondly, it helps feed our hunger for knowledge on disruptive innovation and facilitates the collection of data and the production of missed quantitative-related studies. Along this line, instead of looking for a term best suited to explaining the multifaceted phenomenon of disruptive innovations, it may be the case that we are facing different phenomena and, if this is so, a different term is desirable. Consequently, for those contemplating Christensen's concept of disruptive innovation, the use of alternative terminology such as the "Christensen effect" (Christensen, 2006, p. 42) seems to be an attractive suggestion for further development of the theory.

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Appendix

Table A. Summary of selected articles

Reference	Title	Journal	# Authors	Citations
O'Reilly and Tushman (2004)	The Ambidextrous Organization	Harvard Business Review	2	602
Bower and Christensen (1995)	Disruptive Technologies - Catching The Wave	Harvard Business Review	2	527
Phaal et al. (2004)	Technology Roadmapping - A Planning Framework ...	Tech Forec & Social Change	3	355
Johnson et al. (2008)	Reinventing Your Business Model	Harvard Business Review	3	328
Danneels (2004)	Disruptive Technology Reconsidered: A Critique ...	Journal Of Product Innov Manag	1	256
Christensen et al. (2000)	Will Disruptive Innovations Cure Health Care?	Harvard Business Review	3	231
Walsh (2004)	Roadmapping A Disruptive Technology ...	Tech Forec & Social Change	1	144
Christensen et al. (2006)	Disruptive Innovation For Social Change	Harvard Business Review	4	142
Kostoff et al. (2004)	Disruptive Technology Roadmaps	Tech Forec & Social Change	3	134
Song et al. (2008)	Success Factors In New Ventures: A Meta-Analysis	Journal Of Product Innov Manag	4	125
Baker and Sinkula (2007)	Does Market Orientation Facilitate Balanced Innova- tion ...	Journal Of Product Innov Manag	2	122
Massa and Testa (2008)	Innovation And Smes: Misaligned Perspectives ...	Technovation	2	110
Walsh et al. (2002)	Differentiating Market Strategies For Disruptive ...	IEEE Transactions On Eng Manag	3	91
Lee and Park (2005)	Customization Of Technology Roadmaps ...	Tech Forec & Social Change	2	90
Lee et al. (2009)	Business Planning Based On Technological Capabili- ties...	Tech Forec & Social Change	4	89
Prusak and Cohen (2001)	How To Invest In Social Capital	Harvard Business Review	2	88
Lee et al. (2013)	An Integrated Service-Device-Technology Roadmap ...	Tech Forec & Social Change	3	66
Daim and Oliver (2008)	Implementing Technology Roadmap Process ...	Tech Forec & Social Change	2	66
Zeschky et al. (2011)	Frugal Innovation In Emerging Markets...	Research-Technology Manag.	3	63
Robinson and Propp (2008)	Multi-Path Mapping For Alignment Strategies...	Tech Forec & Social Change	2	63
Schmidt and Druehl (2008)	When Is A Disruptive Innovation Disruptive?	Journal Of Product Innov Manag	2	61
Kostoff et al. (2007)	Global Nanotechnology Research Literature Overview	Tech Forec & Social Change	3	58
Islam and Miyazaki (2010)	An Empirical Analysis Of Nanotechnology ...	Technovation	2	57
Walsh et al. (2005)	The Semiconductor Silicon Industry Roadmap...	Tech Forec & Social Change	4	56
Sapsed et al. (2007)	A Bridge Over Troubled Waters...	Research Policy	3	53

