Journal of Technology Management & Innovation

Volume 13 - Issue 4 (2018)

uah / Facultad de Economía y Negocios
Universidad Alberto Hurtado

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Research Articles

Case Studies

ISSN: 0718-2724. (http://jotmi.org)

How diversification affects vertical integration through experience in pharmaceuticals**

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Abstract: The objective of this study is to analyze the choice between internal and external supplier at the manufacturing stage in the Brazilian pharmaceutical industry. We developed a structural equation model with hypotheses on experience, diversification, asset specificity, and vertical integration. We collected data for 1566 drugs registry, including its pharmaceutical form, therapeutic class and operation time of the firm and group. We found that the higher the experience, the lower the vertical integration in the manufacturing stage and a clear mediating effect of experience on the relationship between diversification and vertical integration. As firms advance in experience and the spread of the capabilities throughout the industry, agents concentrate activities on the relevant stages in value creation and strategically outsource the manufacturing. As the firm increases the diversification in the product portfolio, the experience favours the building of capabilities to manage the production lines and strategies for outsourcing. This result suggests a low risk for strategic alliances at the manufacturing stage.

Keywords: governance structure; strategic alliance; drugs manufacturing

Submitted: April 3rd, 2018 / Approved: May 8th, 2018

Introduction

This study deals with the influence of capabilities and transaction costs on the adoption of governance structures in the manufacturing stage of a productive system, following previous studies on the relationships between the approaches of organizational economics and competences (Hoetker, 2005; Nakamura & Odagiri, 2005; Williamson, 1999). The research context is the pharmaceutical industry, which is highly dynamic in technological innovation and acquisitions. In Brazil, we have observed institutional changes, government incentives and the growth of local laboratories (Silva & Ruiz, 2011).

The Transaction Cost Theory (TCT) argues that the firm is a nexus of contracts as a response to the increase of transaction costs using the market (Coase, 1937) and that agents present bounded rationality and may behave with opportunism. The unit of analysis is a transaction between productive stages, with the dimensions of frequency, uncertainty, and asset specificity. The last of these is prevalent in empirical studies and shows the potential for the loss of earlier specific investment in the absence of the transaction. Thus, the choice of governance structure is a rational choice that aims to minimize the transaction costs arising from the hazard of opportunistic behavior by the counterpart in the transaction (Williamson, 1991, 1999). This framework is useful for studying contractual arrangements in productive systems, such as franchising in retail markets or strategic partnerships in R&D activities (Ménard, 2006).

The capabilities approach has sought to understand the processes of adaptation and change in organizations in changing environments (Dosi, Nelson, & Winter, 2000; Teece, Pisano, & Shuen, 1997). The concept of routine is useful in this approach as a basic unit of variation, selection, and replication that allows the firm to adapt to environmental changes. This process would explain the functioning of economic systems in the evolutionary theory proposed by Nelson and Winter (1982). There are ambiguities to apply the concept of routine in empirical studies (Becker, 2004).

To advance with a potential integration between the two approaches (Jacobides & Winter, 2005), we propose the following research question: what is the influence of transaction costs and capabilities on the vertical integration of manufacturing in the pharmaceutical industry? The general objective is to analyze the impact of transaction costs and competences on the choice between an internal and an external supplier for drug manufacturing in the pharmaceutical industry in Brazil. The specific objectives are the following. First, to develop a theoretical model with relationships between the constructs of experience, diversification, asset specificity, and vertical integration. Second, to measure the constructs with secondary data for products of the pharmaceutical industry. Third, to test the construct validity of the proposed model. Fourth, to evaluate the hypotheses of the model for the relationships between the constructs.

Concerning transaction costs, we measured asset specificity with two dimensions: the presence of differential aspects in the product (Bigelow & Argyres, 2008), and the share of products with some attributes in the firm's portfolio. To examine the capabilities, we adopted the constructs of experience and diversification. The first of these was measured using the time for which the firm or group had operated in the industry (Bataglia & Meirelles, 2009; Bataglia, Silva, & Klement, 2011; Dosi et al., 2000).

We adopted the diversification construct considering the view of the firm as a bundle of capabilities (Kogut & Zander, 1992), and our intention to measure it by the share of the firm´s product portfolio in

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** The authors thank FAPESP (São Paulo Research Foundation) and CNPq (National Council for Scientific and Technological Development) for the financing support for the development of this work.
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ISSN: 0718-2724. (http://jotmi.org)

the set of product types available in the market. This concept is a narrower one than the deployment of the knowledge base of the firm in different markets (Klein & Lien, 2009).

As the pharmaceutical industry has grown, firms adopted the hierarchy as the predominant governance structure in the various stages of the value chain, generating large and vertically integrated corporations. From the 1980s onwards, strategic alliances increased, first abroad and, later, in Brazil (Estrella & Bataglia, 2013; Macedo & Bataglia, 2012; Powell, White, Koput, & Owen-Smith, 2005). At the manufacturing stage, the motivation for a firm with traditional products to outsource would be its competition with companies that offer similar products. When adopting outsourcing at this stage, firms may rely on multiple vendors for common industrial requirements. Thus, companies that are focused on innovative products can reduce their production costs and increase their margins in the period between the launch of the product and the entry of similar or generic products (Polastro, 1999).

To get the registry as a drug producer in Brazil, companies must operate according to the "good manufacturing practices" defined by the National Agency of Sanitary Surveillance (ANVISA, 2010). Firms need to achieve tight control of their processes, and this can lead to vertical integration becoming predominant. If the company outsources particular stages, the regulator must also approve the contractor. This option requires a close relationship with the contractor to perform tasks from the design of processes to the quality management of the final products.

We assumed that the "make or buy" strategic decision (Bataglia & Yu, 2008) in manufacturing corresponds to the choice between vertical integration and a strategic alliance for outsourcing. We can measure this by the presence of vertical integration at each stage of production, or by an index measuring the proportion of vertical integration at all stages, following Hoetker (2005) and Nakamura and Odagiri (2005).

The study has five sections. The second presents the theoretical framework, and the third explains the methods used in this research, including the data and procedures. We show the results in the fourth section, and we include the discussion and final considerations in the last part.

Theoretical Framework and Hypotheses

This section presents a conceptual model for the explanation of governance structures in the manufacturing stage, based on the transaction cost and capabilities approaches. Williamson (1999) suggests that the attributes of a transaction could explain the choice of generic governance structure, while aspects of organizational learning could also influence some aspects of the chosen governance structure. The theme of governance structures covers an extensive research field, especially for hybrid structures (Ménard, 2004). However, we limited our analysis of governance structures with a frequent variable in empirical studies of TCT: the choice between internal (make) and external (buy) supplier (Hoetker, 2005).

The second limiting choice was our focus on transactions at the manufacturing stage, concentrating on its relevance in infant industries like the pharmaceutical industry in Brazil. Nogueira (2011) observed this process with the Brazilian laboratory Aché, which initially grew with the support of partnerships with multinational companies for plant acquisitions and drugs licensing. In recent years the company has accumulated manufacturing expertise and resources to increase its market share and generate revenues to conduct product innovation activities.

We developed the conceptual model following the work of Jacobides and Winter (2005). They argue that the distribution of productive capabilities between firms in an industry defines the difference in vertical scope, with transaction costs presenting a moderating effect. The approach in the present model is similar, but we consider only the operating capabilities of the firm owning the product. We chose this approach considering the adoption of the product as the unit of analysis and the influence of the firm's capabilities on a specific transaction. The model of Jacobides and Winter (2005) refers to the analysis of a population of firms in an industry to measure the distribution of capabilities. Nogueira and Bataglia (2012) proposed a conceptual model to explain the choice of supplier for manufacturing, based on transaction costs and the capabilities of the firm owning the product.

Drawing upon the work of Dosi et al. (2000), Kogut and Zander (1992), and Jacobides and Winter (2005), we expect that the organizational knowledge stored and expressed in routines to be built by the limits of the firm, particularly in the manufacturing stage. According to this approach, the environment of the firm allows groups of employees to exchange experiences and to promote organizational learning. This conditions can help the definition of an appropriate level of specialization in the different stages of the value chain.

Henderson and Cockburn (1994) found two relevant types of capabilities for R&D activities in the pharmaceutical industry: component and architectural capabilities. Component capabilities refer to skills in disease categories and specific issues that support the development of medicines. Architectural capabilities address to the ability to combine the disciplines and areas of therapeutic classes within the firm. For these authors, the experience could be useful for measuring both types of capabilities.

Since the focus of this work is the manufacturing stage, we assume that experience might be relevant and measured it by how long the firm has run in the industry. Bigelow and Argyres (2008) consider the influence of the firm's experience in the industry on the choice of governance structure. These authors argue that as the firm gains experience, it will specialize in activities with higher participation in the total cost of the value chain of the product. In this sense, they expect a tendency to operate on product development and to outsource manufacturing and distribution. Along these lines, we propose the following hypothesis:

> *Hypothesis 1 (H1). The experience of the firm in the pharmaceutical industry has a negative relationship with vertical integration in the manufacturing stage of the product.*

The diversification of a company reflects the range of different types of delivered products. In the pharmaceutical industry, we can describe a product by its pharmaceutical form, therapeutic class, and regulatory category. We expect that successful pharmaceutical companies have a minimum efficient size and offer a diverse portfolio of products, to achieve economies of scale in their production systems and risk management in their R&D to deliver new products to the market (Bogner, 1996). A diversified portfolio can influence the operational capabilities by exposing this functional area to a broad range of pharmaceutical forms. In this sense, this characteristic of a company's capabilities might encourage it to internalize its manufacturing. Following this reasoning, we derive the hypotheses below:

Hypothesis 2 (H2). The diversification of the firm in the attributes of its products has a positive relationship with vertical integration in the manufacturing stage of the products.

Asset specificity is an attribute often discussed in the TCT literature as a relevant factor in the choice of governance structure. The rationale is that the investment in transaction-specific assets favours the adoption of the hierarchy to coordinate the transaction rather than contracting with external suppliers. The existence of a transaction-specific asset resulting from investment by one partner leaves this agent in a disadvantageous position and subject to opportunistic behavior by the other partner (Williamson, 1991). Under these conditions, there is a tendency for the agent to internalize the transaction for the firm. The hypothesis is as follows:

Hypothesis 3 (H3). Asset specificity in the manufacturing stage of a product in the pharmaceutical industry has a positive relationship with vertical integration at that stage.

The literature is scarce on the relationship between transaction costs and operational capabilities and it presents some difficulties for researchers, because each of them address a different object, respectively the transaction and the firm. However, we can assume that the transactions carried out by the firm can influence its productive capabilities. According to Jacobides and Winter (2005), the productive capabilities rest on the firm's general and specific knowledge of how to do things and also involve specific investments in equipment and the training and retention of the key personnel required to put that knowledge to work.

The moderating function of transaction costs on the relationship between the distribution in an industry of the productive capabilities of firms and the vertical scope is discussed by Jacobides and Winter (2005). They offer two hypotheses. First, if capabilities are dissimilar along the value chain, then potential gains from trade across the firm's boundaries exist, and so a reduction in transaction costs will lead to substantial disintegration. Second, if capabilities are similar along the value chain, then there are no expected gains from trade across the firm's boundaries, and so a reduction in transaction costs will not lead to substantial disintegration.

Argyres and Zenger (2012) presented a critical view of this approach. They recognize that the empirical research in the literature corroborates this straightforward application of the comparative logic on capabilities to boundary choices. However, they argue that transaction costs and competences intertwine dynamically as the determinants of firms' boundaries. In the original phase of forming capabilities, transaction cost considerations have relevance to firms in deciding whether to retain, develop or sell off the competences. Argyres and Zenger focus on how organizations build their capabilities in their early and later boundary decisions and consider that, besides serendipity, the distribution of competences across firms and their suppliers reflects the transaction costs of operating in the past.

The aim of the model and the hypotheses we have presented is to deepen the comprehension of the role of capabilities and transaction costs in the choice of the boundaries of the firm in the manufacturing function. To test these hypotheses, we have developed a structural equation model (Williams, Edwards, & Vandenberg, 2003).

Methods

This section presents the methodological procedures followed in the study. We designed and conducted the research with the data from the public records on drugs in Brazil. The text contains the description of the procedures, involving the definition of the unit of analysis, the measurement of the constructs and the strategy for data analysis.

Concerning the research universe, we chose the set of drugs registered and approved for marketing in Brazil by the National Agency for Sanitary Surveillance (ANVISA). Within this universe, the object of analysis is the drug manufacturing transaction. According to the definition of ANVISA (2010), manufacturing involves the stages of production, fractioning, and packaging. For this object, we considered the constructs of Asset Specificity, Experience, Diversification, and Vertical Integration. We present the indicators of the constructs in the next section.

With these constructs, the unit of analysis is the drug's registration in ANVISA, and we opted for the collection and analysis of the total population of records in the official database called Bulário Eletrônico (<http://www.anvisa.gov.br/datavisa/fila_bula/index.asp>). In the new database created for the research, we defined the product as the combination of the active principle with the pharmaceutical form, since a drug may present two or more forms, and there may be different levels of vertical integration for each one. For example, the drug Acheflan (Aché Laboratories) is one case in ANVISA but generates two products in the new database: Acheflan cream and Acheflan aerosol. We followed four steps to construct our dataset. First, the extraction of data on the drug registration from ANVISA, second, the generation of records of products. The third step was a search and collection of the time for which the firms that own the products and their groups have operated, and fourth, a calculation of the indicators of the latent variables and constructs, as presented in the next section.

Measurement of Latent Variables

We created indicators for the latent variables with drug registration data in ANVISA. Starting with the product, we searched other sources and collected the name of the firm and its owner or holding corporation, defined as the group and the experience, measured by the length of time for which the firm and the group, respectively, had been in operation. Thus, this study provides a methodological contribution to the measurement of capabilities and transaction costs based on secondary data for products in the pharmaceutical industry.

Considering the information available in the official database, the indicators of the drug used in this study were the vertical integration, the pharmaceutical form, and therapeutic class. The pharmaceutical form is a physical aspect, such as pill, liquid or cream. There are 62 forms in ANVISA, and we converted each one in dichotomous variables of the product.

The drug's function for diseases or human organs is the therapeutic class, which we measured by 72 dichotomous indicators (Classes). Besides that, we created 13 anatomic classes, resulting from the aggregation of similar therapeutic classes by organs and systems of the human body (Agg Class). This method is an international standard for drug classification, the Anatomic Therapeutic Chemical (ATC) system of the World Health Organization (WHO, 2011).

We measured Vertical Integration by an endogenous variable with the same name and eight indicators. The drug label identifies the firm responsible for each stage of manufacturing: production, fractioning and packaging. We used the choice between vertical integration and an outsourcing contract (which, by definition, was a strategic alliance contract) (Ménard, 2004, 2006). The dichotomous indicators for the firm are "Make Prod in Firm" (internal supplier for production), "Make Pott in Firm" (internal supplier for fractioning) and "Make Pack in Firm" (internal supplier for packaging). Similarly, the indicators for the group are "Make Prod in Group," "Make Pott in Group" and "Make Pack in Group". The scalar indicators were the number of stages in which the internal supplier (or, respectively, the group) participated, as a percentage of the total number of stages ("Vertical Integ in Firm" and "Vertical Integ in Group").

Two indicators measured the variable Experience. First, "Firm Time," the time in years for which the firm had operated in Brazil. Second, "Group Time," the time in years for which the oldest firm in the group had operated.

For the variable Diversification, we adopted four indicators at the firm and group level, being two related to forms and two for therapeutic classes. First, "Firm in Forms," the number of distinct forms of the firm divided by the total number of forms. Second, "Group in Forms," the similar indicator at the group level. Third, "Firm in Classes," the number of distinct classes of the firm divided by the total number of classes. Fourth, "Group in Classes," the correspondent indicator for the level of the group.

We measured the variable Asset Specificity with three dichotomous indicators. We transformed the list of 62 pharmaceutical forms from ANVISA (2011) into dichotomous measures assigned to the product. We then created new indicators called "aggregate forms" by grouping the original forms with common attributes related to asset specificity. First, "Release Attribute in Agg Form," the aggregate form composed of original forms with specific attributes related to releasing the drug in the human body. Second, "Pack Attribute in Agg Form," the aggregate form composed of original forms with specific attributes related to fractioning or packaging. Third, "Any Attribute in Form," an indicator of an original form with any specific attribute.

Strategy for Data Analysis

We evaluated the data with three steps. The first was the central tendency and dispersion in the population with descriptive statistics. The second was the partial correlation coefficients between the indicators. The third was the analysis of a structural equation model, with evaluation of the measurement model and the structural relationships to test the hypotheses using the partial least squares (PLS) method. The PLS method is a technique of structural equation modeling to analyze the causal relations between constructs. This technique does not require multivariate normality in the distribution of the variables (Wold, 1985).

We constructed the variables Vertical Integration, Experience, Diversification and Asset Specificity reflectively with their indicators (Edwards & Bagozzi, 2000). The coefficients of the structural model represent standardized regression coefficients, and the loads of the latent variables associated with the constructs are the factor loadings. The significance was determined by the Bootstrap method with 1000 repetitions. A value of $p < 0.05$ ($t >= 1.96$) was used for significance tests.

Results

In this section, we present and discuss the results of the data analysis. First, we show the general characteristics of the data with the structure of the indicators. The following part contain the evaluation of the descriptive statistics and correlations. In the last part, we present the results of the proposed structural model. In a preliminary data investigation, there were no missing values. We evaluated outliers with the Mahalanobis distance test, resulting in the identification and exclusion of 40 cases.

Descriptive Statistics and Correlations

The database contains 1566 products associated with 111 firms consolidated into 88 groups. For Vertical Integration we found the equal averages for production and fractioning in the firms at 61.00%, lower than the value for groups, 83.00%. The same is true for packing inside the firms (73.00%) and the groups (90.00%). For the scalar aggregate indicators, the value for firms (64.75%) is also lower than that for groups (85.55%).

The data for Experience reveals that the average time for which the firms had operated in Brazil (50 years) is less than this indicator for the groups (148 years), reflecting the relatively short history of manufacturing in Brazil compared with the age of foreign pharmaceutical

groups. The results for Diversification showed an average share of 25% of the total number of forms for the firms and 53.23% for the groups. This difference reflects the function of a group to increase diversification in forms. The share of the total number of classes is 25% for the firm and 32.7% for the group, revealing that a group has a relatively minor effect on this diversification, perhaps because of the higher costs involved in the development of the capabilities in different therapeutic classes.

For Asset Specificity, the average frequencies for the aggregate forms are 10% for the packing attribute and 30% for the release attribute. The shares for the aggregate class are 30.75% for firms and 25.12% for groups. We analyzed the partial correlations between the indicators and found values between 0.30 and 0.60, and in some cases values greater than 0.80, which allows the application of multivariate analysis, such as factorial analysis using structural equations.

Construct Validity

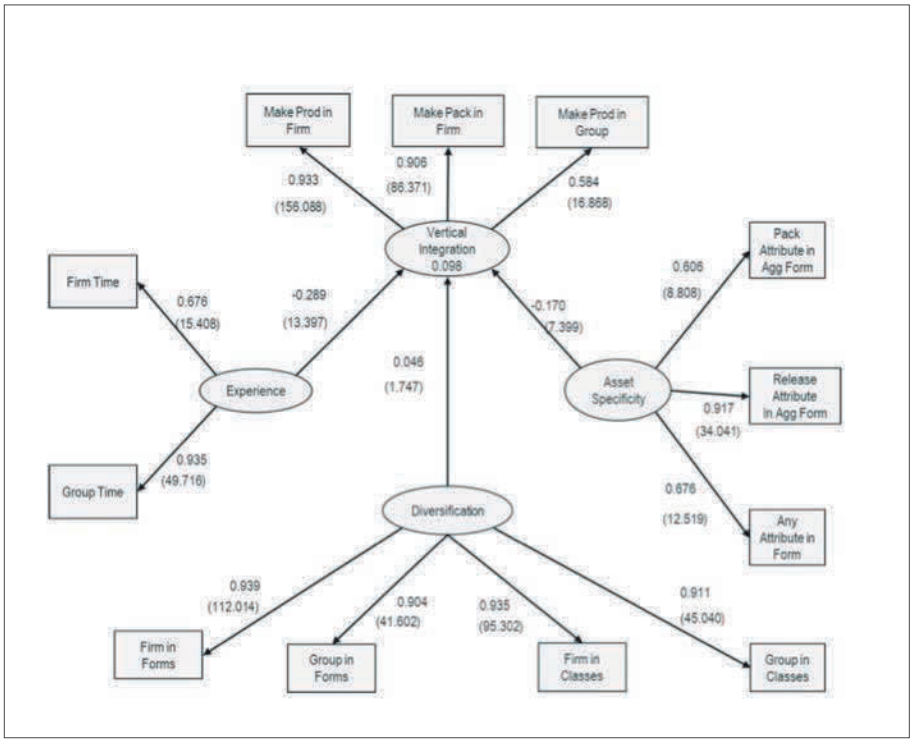
In this section, we discuss the validity of the scale used to measure the constructs. We used tests of reliability and convergent and discriminant validity with the software SmartPLS 3.2.7 (Ringle, Wende, & Becker, 2015). Figure 1 shows the measurement model estimated by PLS after the validation stage. The ovals include the variable and the percentage of variance explained by the relationships with other variables. We present the loads and t values in the arrows for latent variables and indicators. The criteria for acceptance of an indicator was the statistical significance ($p < 0.05$, $t >= 1.96$) with the value superior to 0.45 of the load. Most of the loads are above 0.60 and exhibit $p < 0.01$ ($t >= 2.576$), indicating its adaptation.

In re-specification of the model, we eliminated the indicators Make Pott in Firm and Vertical Integ in Firm because of multicollinearity, as indicated by offensive loads. The second round of model calculation excluded the indicators Make Pott in Group (load = -0.174, t = 0.073), Make Pack in Group (load = 0.111, t = 0.058) and Vertical Integ in Group (load = 0.220, t = 0.037) because of the lack of significance of the loads.

Concerning Experience, both indicators showed significance. It is noteworthy that Group Time has a higher load than Firm Time. This result may reflect the high share of foreign products in the population (70%) since all belong to firms with a higher average age than the domestic firms. For Diversification, all the indicators showed loads higher than 0.600 and appropriate significance. Asset Specificity had loads suitable for the first-order variables used in its measurement. Form Specificity showed a load about twice as large as that for the variable Class Specificity.

The reliability of the constructs was based on three criteria: reliability of lower-level variables; composite reliability (the construct) (acceptable values > 0.70); and average variance extracted (AVE) (acceptable values > 0.50) (Chin, 1998). We assessed the reliability of the variables related to the constructs by the magnitude of the respective factor loads. Most loads must be at least 0.60, and ideally, they should be at or above 0.70 (Chin, 1998; Falk & Miller, 1992). We can see in Figure 1 that the only one item present a load bellow 0.60 (Make Prod in Group) and eight loads are higher than 0.90. Table 1 shows the composite reliability and average variance extracted (AVE). Both meet the established suitability criteria.

Figure 1 – Mensuration model re-specified with coefficients*



The analysis presented in Table 2 supports the convergent validity for the constructs of the model, as it indicates higher loads in absolute value for the indicators related to the latent variables, as predicted by the model, with smaller loads for the other variables (Chin, 1998).

Table 1

Measurement of construct reliability

Variable	AVE	Composite Reliability
Experience	0.666	0.795
Diversification	0.851	0.958
Asset Specificity	0.555	0.784

We tested the discriminant validity using the method of Fornell & Larcker (1981). All constructs in the model showed discriminant validity, as the square root of the AVE for the latent variables, displayed in bold on the diagonal of the correlation matrix (Table 3), are higher than the other latent variables.

Table 2

Cross loads for evaluation of convergent validity

Indicator	Asset Specificity	Diversification	Experience	Vertical Integration
Pack Attribute in Agg Form	**0,606**	0,052	0,060	-0,070
Release Attribute in Agg Form	**0,917**	-0,042	-0,057	-0,180
Any Attribute in Form	**0,676**	0,044	0,037	-0,075
Firm in Classes	-0,011	**0,935**	0,572	-0,135
Group in Classes	-0,023	**0,911**	0,468	-0,096
Firm in Forms	0,024	**0,939**	0,592	-0,117
Group in Forms	-0,002	**0,904**	0,463	-0,082
Firm Time	-0,032	0,139	**0,676**	-0,128
Group Time	-0,001	0,660	**0,935**	-0,267
Make Prod in Firm	-0,175	-0,146	-0,247	**0,933**
Make Pack in Firm	-0,139	-0,092	-0,260	**0,906**
Make Prod in Group	-0,069	-0,004	-0,046	**0,584**

Table 3

Cross correlation of first level latent variables

	Asset Specificity	Diversification	Experience	Vertical Integration
Asset Specificity	0,745			
Diversification	-0,003	**0,922**		
Experience	-0,013	0,577	**0,816**	
Vertical Integration	-0,166	-0,120	-0,261	**0,823**

Analysis of Structural Model

As shown in Figure 1, the explained variance for the dependent variables of the model (R^2) is below but near 10%, revealing an adequate predictive power of the PLS model (Falk & Miller, 1992). In Table 4, we present the hypotheses and test results, where the structural factors were significant except for H2.

Table 4

Test of hypotheses of the model

Hypothesis	Proposed Effect	Regression Coefficient	Observed *t* Value	Hypothesis Supported
Effect on Vertical Integration (R^2 = 0.098)				
H1: Experience ➔ Vertical Integration	-	-0.289	13.397	Yes
H2: Diversification ➔ Vertical Integration	+	0.046[a]	1.747	No
H3: Asset Specificity ➔ Vertical Integration	+	-0.108	2.663	No

[a] Non-significant

Hypothesis H1 proposes a negative relationship between Experience and Vertical Integration. We found a negative and significant structural coefficient, which does support this hypothesis.

Hypothesis H2 establishes a positive relationship between Diversification and Vertical Integration. The model shows a positive and not significant structural coefficient, which do not support the hypothesis related to the view of the firm or group as a bundle of capabilities. To deep the comprehension on this result, we investigated the presence of mediating and moderating effects of the constructs Experience and Asset Specificity in this relation. We tested more five new models, whose results are in the following paragraphs.

The second model tested the influence of Diversification on Vertical Integration, grouping just these two constructs, resulting in a negative structural coefficient (-0.134) with significance (t = 6.84) and a lower explanation power for Vertical Integration ($R^2 = 0.018$) than the first model of the Figure 1. The third model tested the simultaneous influence of Diversification and Asset Specificity on Vertical Integration, keeping just these three constructs. The structural coefficient for the relation between Diversification and Vertical Integration was lower than the second model, but still negative (-0.123) and significant (t = 5.262). The structural coefficient for the relation between Asset Specificity and Vertical Integration was also negative (-0.168) and significant (t = 7.417), and this model showed a higher explanation power ($R^2 = 0.043$) for Vertical Integration than the second one. These results indicate the inexistence of mediating effect of Asset Specificity on the relationship between Diversification and Vertical Integration.

The fourth model tested the relationships of Diversification and Experience on Vertical Integration. The explanation power of this model for Vertical Integration was higher than the second and third model ($R^2 = 0.071$). The structural coefficient for the relation between Diversification and Vertical Integration was positive (0.047) and not significant (t = 1.669), while the structural coefficient for the relation between Experience and Vertical Integration was negative (-0.292) and strongly significant (t = 14.245). These results show a clear mediating effect of Experience on the relation between Diversification and Vertical Integration. Thus, the original negative and significant effect of Diversification on the Vertical Integration of the second model disappeared.

Along these lines, we may add the following new propositions in this work:

> *Proposition 1 (P1). The diversification of the firm in the attributes of its products has a negative relationship with the vertical integration in the manufacturing stage of the products in the pharmaceutical industry.*
>
> *Proposition 2 (P2). The experience mediates the relation between diversification of the firm and the vertical integration in the manufacturing stage of the products in the pharmaceutical industry.*

The fifth and sixth models tested the moderation effect of experience and asset specificity on the relationship between Diversification and Vertical Integration. The results showed the inexistence of moderating effects.

Hypothesis H3 suggests a positive relationship between Asset Specificity and Vertical integration. The model presented a negative and significant coefficient, which contradicts the proposed hypothesis. It appears that the manufacturing does not have the strategic relevance to justify vertical integration when asset specificity increases. This result suggests a low perceived risk of opportunistic behavior in the outsourcing of manufacturing stage.

Discussion and Final Considerations

The study aimed to analyze the influence of transaction costs and capabilities on vertical integration for the manufacturing stage in the pharmaceutical industry in Brazil. The objective was to contribute to the research agenda on the relationship between the transaction costs and capabilities approaches, particularly about the adoption of a governance structure in a production system. While the TCT has been successful in confirming its hypotheses in empirical studies, the capabilities approach still faces some difficulties in the measurement of constructs, but there has been a growing application of some aspects of this approach in the area of strategy. In this section, we present the main implications of the results of the testing of the hypotheses of this work.

The result of the test of hypothesis H1 indicated that, in the pharmaceutical industry, the higher the experience, the lower the vertical integration. In the pharmaceutical industry, pioneer firms had an integrated structure because of the industry regulation and the low initial dissemination of capabilities among agents. As time passed with the firms operating and the spread of the capabilities throughout the industry, it seems that these firms focused on activities with relatively higher participation in value generation. In this sense, the firms limited their operations in the most relevant stages in the value chain, considering the participation in the total cost of the product, outsourcing the manufacturing stages with less relevance on these criteria, whenever suppliers are available in the market. We can also see this behavior in the automotive and telecom industry.

We rejected the hypothesis H2 (a positive influence of Diversification on Vertical Integration) and analysed some alternative models to investigate the mediating and moderating effects of the experience and asset specificity in this relation. The results of these models showed a clear mediating effect of Experience on the relationship between Diversification and Vertical Integration and the inexistence of moderating effects. The effect of the inclusion of Experience was the cancelling the original negative effect of Diversification and the increase of the total explanation power of the model for the Vertical Integration.

By this result the influence of diversification on vertical integration occurs only in presence of the experience. There are some theoretical reasons for this statement. First, the experience must help the firms in this industry to decide the level of vertical integration for the portfolio of products. The operation time favour the firm to concentrate its activities on the more relevant stages in value creation of each product. As the firm increases the diversification in the product portfolio, the experience will support the decision on vertical integration, balancing production costs and the participation on the revenue of each product.

The second reason for the influence of experience on diversification is the building of capabilities to manage the production lines, regarding therapeutic classes and the administration forms of the products. For each movement of launch products with diverse therapeutic class and form, increasing the diversification, the capability to manage the production lines will direct the decisions to explore the available productive assets with adaptations, to invest in new equipment's or to contract an external supplier for the new product if available.

The third reason for the dependence of diversification on experience in vertical integration decisions is the capability to manage the strategic alliances related to the manufacturing stage. Since the experience with the management of earlier alliances is central to increase this capability, the decision of vertical integration when the firm raises the diversification is affected by the operation time.

The fourth reason of the relationship of diversification and experience is that both are associated with scale of production. We expect the increase of diversification with experience, in order to reduce the market risks with a balanced portfolio with innovative and older products. In this sense, the increase of diversification could be associated to the scale of production. The decision of vertical integration when the scale is raising depends on the availability of capital for new plants and the profitability of establishing strategic alliances for the manufacturing stage.

One contribution of the study is that we could highlight the difference in the kind of capabilities measured in each proxy, since diversification measures the number of different competences of the firm in form and class, while experience relates to the learning curve related with productivity gains.

We found a negative relationship between asset specificity and vertical integration (hypothesis H3). The rejection of the hypothesis, rather than suggesting the invalidity of TCT, seems to be due to aspects of the industry and of the transaction in question. The result seems to indicate that the drug manufacturing transaction has low strategic value in the value chain of the pharmaceutical industry. We suspect that companies tend to outsource the manufacturing of products with specific attributes, preferring in some cases to use the capabilities of a partner rather than those of the internal supplier, as the TCT prediction. The result indicates that these specific attributes do not appear to represent sources of transaction costs arising from the risk of opportunistic behavior by partners. We can argue that a strategic alliance at the manufacturing stage for products with specific attributes presents a low risk that the service provider will hold up the supply. The reason for this assumption is the appropriating structure for the R&D investment made by agents in this industry, centred on the patenting of active principals of the drugs.

One limitation of the study relates to its exploratory nature. Attempts to establish relationships between the transaction costs and capabilities approaches are still at a nascent stage, although empirical evidence is already accumulating about the possibilities of a complementary application of the theories. However, the literature has not yet reached a consensus on the feasibility of a more general and integrated theory. We suggest that the results and the implications derived from this work require a precautionary interpretation in view of the characteristics of the indicators and the structural model used. Our attempt to use secondary data about products as a starting point to generate data about firms may contain biases related to capabilities. We could not evaluate the origin of products, whether developed internally or came into the portfolio by mergers or acquisitions. The second limitation of this study relates to the distribution of cases between domestic and foreign firms and groups. The population that we tested reflects a market segment with a predominance of new drugs mostly produced by foreign companies. Future studies should also evaluate the influence of the categories of innovative and generic on the vertical integration of manufacturing stage.

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Team collaboration capabilities as a factor in startup success

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Abstract: This paper discusses the role of team collaboration as a building block for cultivating capabilities in technology-based startups. This conceptual framework draws on a literature review of innovation and entrepreneurship research to understand the intra-organization collaboration mechanisms among team members in technology-based startups. Introducing the concept of team collaboration capabilities represents a new approach to understanding the interaction conditions that give rise to new capabilities from a venture team as its organizational base. Rapid new capability building represents a competitive advantage in environments characterized by innovative technological change, known as dynamic capabilities.

Keywords: Technology-based startup team; technology-based startups; team collaboration capabilities; dynamic capabilities; collaboration; capability building

Submitted: July 12th, 2018 / Approved: November 6th, 2018

1. Team collaboration capabilities: issues and gaps

The purpose of this paper is to connect, through entrepreneurship and innovation management literature, the introduction and justification of team collaboration capabilities as a new approach to understanding dynamic capability building as an outcome of interaction conditions within the organization of technology-based startups. The complexity of the concept requires the integration of various micro-dimensional conceptual layers that must be aligned to understand the factors that affect collaboration in the organization of small-scale technology-based startups. We describe and explain the term team collaboration capabilities grounded on the origin, purpose, and composition of technology-based startup teams, as their essential organizational basis.

The framework for this study is dynamic capabilities. Dynamic capabilities are the antecedents of organizational and strategic routines, focusing on the fast-track reconfiguration of resources in the firm. Dynamic capabilities have attracted extensive scholarly attention in large firms in relation to inter-organizational collaboration, in which teams and organizations coordinate a range of processes such as the supply chain, commerce, and distribution, among others; researchers have also explored this collaboration under extraordinary conditions such as mergers and acquisitions in innovation environments. Dynamic capabilities also explain how firms generate new value-creation through strategies in rapid technological change contexts (Teece et al., 1997; Eisenhardt & Martin, 2000)shaped by the firm's (specific. However, there is little research on the micro foundational processes of capability building, particularly in technology-based startups in the entrepreneurship literature. Technology-based startups are dynamic firms that represent organizations with entrepreneurial activities founded on the results of scientific and technical research and fieldwork. To date, the role of the team in technology-based startups has attracted little interest in the entrepreneurial research, even though teams are regarded as the essential condition of this type of organization, especially in the way they develop unique capabilities that allow the firm to create and maintain a competitive advantage.

Due to their high degree of novelty and disruption, launching the products and services of a technology-based startup demands intense and continuous work on international activities in often uncertain conditions. At the same time, the internal activities of the technology-based startup team involve coordinated group work; they constitute the essence of interaction generated by the internal and external collaborative work the team's members carry out. This collaborative team work in a technology-based startup drives the success of innovative projects (Hoegl & Gemuenden, 2001)that \"good teamwork\" increases the success of innovative projects, raises new questions: What is teamwork, and how can it be measured? Why and how is teamwork related to the success of innovative projects? How strong is the relation- ship between teamwork and various measures of project success such as performance or team member satisfaction? This article develops a comprehensive concept of the collaboration in teams, called Teamwork Quality (TWQ. The members of a technology-based startup team deal with a high level of technological knowledge, which enables them to attain a high level of capabilities. In this respect, the concentrated, diverse and continual exchange of activities combine sophisticated knowledge, in which aspects such as trust, communication, problem-solving and team efficacy frequently play a relevant role. (Khan et al., 2014)it investigates the interaction effects of LOC diversity and affective trust on the internal LOC-performance relationship. Design/methodology/approach – Data originated from 44 entrepreneurial teams based in nine business incubators in Austria. Partial least squares (PLS. Hence the importance of studying the functions of technology-based startup teams as a necessary factor in understanding their internal innovation development processes, considering the key two-faceted nature of team collaboration: first, to strengthen and protect the firm's internal processes in developing innovation; and second, to prevent external failure caused by lack of cohesion efforts from inhibiting the innovation's progress.

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The conditions of technology-based startup teams demand the intense involvement of their members in collaboration. Here, the complexity of building new capabilities coexists with exploitation of existing basic capabilities to adapt the organization for survival in conditions of extreme pressure. This paper focuses on the phenomenon of technology-based startup teams in an attempt to provide a different approach to the team members' interactive role––defined as team collaboration capabilities––as a different micro-foundation perspective of dynamic capabilities. The paper takes the following structure: Section 2 introduces a definition of technology-based startups and two fundamental multidimensional aspects of their organization, namely, team-building conditions and team member characteristics. Section 3 introduces the conceptual framework we use to analyze the interrelationships between dynamic capabilities and collaboration as a condition for innovation that leads to the term team collaboration capabilities and its justification. Finally, Section 4 provides the conclusions.

2. Fundamental concepts

2.1 Definition of Technology-Based Startups

The term technology-based startup has been used to define small firms that develop and introduce new technology with a focus on invention, and technological advancements. The concept of technology-based startups is rooted in the entrepreneurship activities linked to a technology (Rammer, 2006). A technology-based startup in its early stages can experience difficulties in the complex processes of translating a "basic science invention" into a commercially viable international "innovation" (Auerswald & Branscomb, 2007). Hence, the progression to global markets becomes intensely competitive and uncertain. This circumstance increases risks in technology-based ventures, which demand an intensification of development, improvement, and delivery of R&D activities. Hart and Denison (1987, p. 512) define technology-based startups as "*ventures that emphasize the role of research and development in the introduction of new products or services or as those that place their major strategic emphasis on the exploitation of technology in products, processes, or services*" (Hart & Denison, 1987, p.512). Technology-based startups are also perceived as young dynamic organizations that pursue an unknown business model in order to disrupt existing markets or create new ones, in which the founders attempt to capitalize on developing a product or service for which they believe there is a demand (Bhave, 1994).

One of the most cited definitions is that of Ries (2011, p.8), in his book *The Lean Startup*, where he refers to a startup as: "*a human institution designed to create new products and services under conditions of extreme uncertainty*". Technology-based startups can be classified according to the firm's conditions and technological inclination, for instance, the case of technology-based startups aiming to launch new applications of technology such as cleantech and renewable energy in green, ecological and sustainable markets (Bjornali & Ellingsen, 2014). The new technological product-concept follows specific trends and must be identified in the market. Particularly, the ideas and concepts of technology-based startups focus on their mission to protect the environment and reduce impacts by facilitating the use of clean energy and environmentally friendly solutions.

The entrepreneurial nature of technology-based startups means they actively promote the launch onto the market of radical innovations in their products, business models, and distribution systems. Moreover, some technology-based startups have made attractive breakthroughs that are in great demand from industrial sectors, supported by processes that cover specific gaps in the industry and meet local regulations. For example, biomaterials can position them as essential to clean-cycling processes in the industry (Bjornali & Ellingsen, 2014). Other authors have also referred to technology-based startups as technology-based ventures, defined as firmly grounded in new knowledge-based entrepreneurship (Bhave, 1994).

According to Paradkar et al. (2015), technology-based startups are managed by entrepreneurs who assess markets, technologies and business models in different ways, for example, by attempting to introduce new products and influence the market by promoting customers' values of awareness in comparison to existing products. Also, these entrepreneurial firms exploit their own ideas, or adapt and integrate ideas of others, to change new or existing assets into meaningful and value-added configurations. The efficiency of a technology-based startup team constantly shapes the organization's functions, where key activities are orchestrated to support the delivery of R&D in new prototype products and, by testing sophisticated services, to determine the strategic market direction (Cohen & Bailey, 1997). Thus, technology-based startups are firms that disturb the *status quo* of established firms, disrupting and altering traditional patterns of behavior with fresh ways of doing things (Teece et al., 1997; Paradkar et al., 2015).

2.2 Team definition and foundation

The organization of technology-based startups is based on a team, which is frequently referred to as a top management team, an entrepreneurial team, a new venture teams, a founding team, a startup team and a technology-based team. The concept of team in technology-based startups involves an entrepreneurial and innovation team organization, which usually emerges within, from, across or outside a firm or institution, such as a university, research institution or industry (Harper, 2008). The internal conditions of technology-based startup team are entrenched with continual collaboration as Hoegl and Gemuenden (2001, p. 436)*that \"good teamwork\" increases the success of innovative projects, raises new questions: What is teamwork, and how can it be measured? Why and how is teamwork related to the success of innovative projects? How strong is the relation- ship between teamwork and various measures of project success such as performance or team member satisfaction? This article develops a comprehensive concept of the collaboration in teams, called Teamwork Quality (TWQ* describe: "*… a social system of three or more people, which is embedded in an organization (context), whose members perceive themselves as such and are perceived as members by others (identity), and who collaborate on a common task*". The concept of the team can be explained by taking into account attributes such as complexity, adaptive capacity, and dynamism (Ilgen et al., 2005) in a context that relates to the entities to which they belong.

Cooney (2005) defines an entrepreneurial team as "*two or more individuals who have a significant financial interest and participate actively in the development of the enterprise*" (p.229). Cooney's definition is, however, quite broad to define the startup of a business. Notwithstanding, the real value teams add to technology-based startups is based on their activities and expertise, which as a whole pursues innovation with a financial interest, and in return recognition is expected to translate into business profits. The founders are individuals that take part in an entrepreneurial venture and constitute the human capital and valuable resources of the technology-based startup team. Harper (2008) highlights the role of a common goal, defining an entrepreneurial team as "*a group of entrepreneurs with a common goal that can only be achieved by appropriated combinations of individual entrepreneurial actions*" (p.614). It is worth noting that the entrepreneurial team could emerge within, across or outside another firm or institution as result of networking by one or more of the founders.

A more extended definition proposed by Schjoedt and Kraus (2009) maintains that: "An entrepreneurial team consists of two or more persons who have an interest, both financial and otherwise, in and commitment to a venture's future and success; whose work is interdependent in the pursuit of common goals and venture success; who are accountable to the entrepreneurial team and for the venture; who are considered to be at the executive level with executive responsibility in the early phases of the venture, including founding and pre- start up; and who are seen as a social entity by themselves and by others." (p.515). This definition emphasizes the pursuit of common responsibilities in objectives and the management of the team and infers a level of equity among the members in regard to the team's performance.

Moreover, further definitions reveal that a 'new venture team' is described as "the group of individuals that is chiefly responsible for the strategic decision making and ongoing operations of a new venture" (Klotz et al., 2014, p.227). Ideally, all the team members should 'actively' participate and contribute to the development of the organization and implementing operations. Specifically, team members define the guidelines of the business plan and strategy, organize the vision and mission of the technology-based startup, attract investment and recruit talent, among other activities (Klotz et al., 2014).

2.3 Team members' characteristics

The foundation of a technology-based startup team begins around an idea that has already been formed. The creation of the team and group development always take place within a specific context or "ecosystem" (Hart & Denison, 1987). The creation of a technology-based startup team can take place in universities, and private and public laboratories, and usually occur in environments that incubate and nurture technical expertise. Hart and Denison (1987) note that systemic technology conditions determined by institutions and the social context foster the formation and existence of entrepreneurs and the creation of startup teams. In other words, the environment works as a conglomerate of academia, science, finance and training, which are sources that attract and provide the conditions for and availability of highly-qualified technical and scientific human resources. Further, the proximity of the ecosystem in innovation environments increases the chances for technology transfer, seeding new ideas and organizational capabilities for new business opportunities.

The literature shows that criteria for recruiting technology-based startup team members include experience, educational level, previous work experience, affiliation background (university, company), and prior success (Colombo & Piva, 2012). Several researchers observe that diversity of points of view stimulates and contributes to building creative processes such as linking ideas, performing tasks, designing solutions, and organizational structures. Specific team characteristics studied in the entrepreneurial and management literature include team composition, shared personal and professional objectives, professional recognition such as merits, and organizational support and trust (Khan et al., 2014)it investigates the interaction effects of LOC diversity and affective trust on the internal LOC-performance relationship. Design/methodology/approach – Data originated from 44 entrepreneurial teams based in nine business incubators in Austria. Partial least squares (PLS. The interplay for building capabilities requires leadership, management and team members as its human capital, in which formal, codified or explicit knowledge (cognition) is the firm's dominant core logic.

The technology-based startup team requires a stock of human capital directly related to individual skills. The term skills encompasses traits, knowledge, previous experiences and abilities that should be 'orchestrated' between the team's members to shape both the individual and organizational capabilities, linked to the strategy and performance (Azagra-Caro et al., 2017). Highly-skilled team members become the technology-based startup team's human capital, which refers to individuals as sources of knowledge that obtain and develop new skills and expertise through education, training and previous work experience (Attewell, 1999). However, highly-skilled human capital is still not widely appreciated in private sectors, despite the fact that its participation in technological innovation activities represents a significant source of profit. The team depends on the motivation and commitment of its members, who should know and trust each other enough to share the same goals, intention, responsibility and decision making to start a company (Vyakarnam et al., 1999). The formation and professionalization of the team consolidate over time; moreover, it nourishes its dynamic with the intervention of new members and the growth of the organization.

Within the technology-based startup team, its members must define their roles, which include a range of tasks and relationships where aspects like trust are crucial. The entrepreneurs themselves have to legitimize their roles within the '*micro realm*' of their organization as part of the social system by conforming to existing images and stereotypes, and by defining their own rights and duties. Management of the technology-based startup team is influenced by the active interaction and integration of the team members with the firm's other resources, and their responsibilities are defined according to their scientific and technical backgrounds (Klotz et al., 2014). Technology-based startup teams are shaped according to their innovation needs and are nourished by their ecosystem, through interaction with external actors,

especially intermediaries, that facilitate resources to support innovation. Such intermediaries include government agencies, incubators, accelerators, and investors. Various authors also highlight the positive relationship between their operational autonomy and their organizational and strategic performance (Srivastava et al., 2006).

3. Conceptual framework

3.1 Dynamic Capabilities and Collaboration

In innovation environments, collaboration and dynamic capabilities are integrated as an essential condition among different organizations and firms. On the one hand, collaboration for innovation involves complex activities that require a combination of inputs from diverse sources. Collaboration involves different dimensions between individuals, the organization, the team and firms, which may be partners, suppliers or competitors. It implies that all the actors involved contribute with sources and know-how, also as complementary assets and capabilities, together sharing costs and risks for a common aim (Dodgson & Rothwell, 1994). In a technology-based startup, collaboration represents interaction among individuals inside the organization where everyone works together to achieve a clear and shared aim in a specific context. On the other hand, the term dynamic capabilities is complex and controversial, which has therefore led to some disagreement over the concept among experts. Our review analyzed articles focused on the definition and origins of dynamic capabilities from the description of organizational conditions framed by collaboration activities. Teece and Pisano define dynamic capabilities as "*the firm's ability to integrate, build, and reconfigure internal and external resources to address and shape rapidly changing business environments*" (Teece & Pisano, 1994). Dynamic capabilities aim to explain how a firm addresses turbulent market conditions by extending, modifying and reconfiguring existing operational capabilities to better match uncertain contextual conditions. In essence, resources and capabilities are built into the firm.

There are two streams of dynamic capabilities that aim to explain the organizational benefits to deploy the firm's resource base in a strategic way. The first is to determine which resources and capacities produce sustainable competitive advantages; and the second is to identify and assess them. Dynamic capabilities gain insight into different dimensions by examining the resource base of large firms; we look for definitions that conceive teams as the core of the organization. Some academics attribute the possession of a high level of resource base to explain how certain firms achieve and maintain their competitive advantage in contexts of rapid technological change (Teece et al., 1997). Dynamic capabilities constitute an explanation of how exceptional organizational abilities are built through time to survive in turbulent market conditions.

The internal factors that affect dynamic capabilities, according to Bowman and Ambrosini (2009), include (1) managers, (2) position and trajectory, (3) social capital, (4) leadership and (5) and trust. According to these factors, the manager's role depends heavily on his or her individual expertise to harmonize the firm's resources and operations in order to adapt it to the immediate circumstances. In terms of innovation management, one of the main aspects of managerial responsibilities is the development of dynamic capabilities in the organization. Bowman and Ambrosini (2009) propose that dynamic capabilities emerge from the co-evolution of the processes coming from the accumulation of tacit experience with the articulation and encoding of activities of explicit knowledge.

In this respect, complex and diverse collective efforts are concentrated in the technology-based startup teams' internal functions. These efforts are made by two or more individuals who interact with each other and with external actors from within their ecosystem, hold and share responsibility for the firm, and actively influence strategic decisions (Sapienza et al., 2006; Harper, 2008; Khan et al., 2014). Hence, the team's efforts focus mainly on innovation activities, so the team is an organizational 'mechanism' that combines diverse expertise and skills from individuals who have agreed to perform specific tasks in coordination with others, under complex and uncertain conditions, to achieve their objectives (Hoegl & Gemuenden, 2001).

Collaboration and dynamic capabilities are not implicitly integrated concepts; however, the term itself implies that dynamic capabilities at inter- and intra-organizational level demand the tight integration of other synergies that involve 'collaboration' (Blomqvist & Levy, 2006). We conducted a literature search to gain insight on various dimensions by examining reviews of dynamic capabilities to identify collaboration and interaction as essential factors of new capability building (see Table 1).

Table 1. Published reviews on the concept of dynamic capabilities based on team members' interaction or collaboration.

Year	Author/s	Title	Journal name	Intra-team interactions/collaboration influences dynamic capabilities
2000	Deeds, DeCarolis, and Coombs	Dynamic capabilities and new product development in high technology ventures: An empirical analysis of new biotechnology firms	Journal of Business Venturing, 15 (3), 211-229	*"…what a high-tech venture needs is leadership that understands and has experience in the new product development process, but is independent and distinct from the scientific team. This kind of leadership maintains the* ***scientific team focused on research and development, and out of the boards.****" (p. 212)* *"According to dynamic capabilities theory, firms compile knowledge, expertise, and skills through organizational learning. Learning capabilities enables firms to perform their activities in improved ways.* ***Organizational learning happens when their members interact with each other and develop common codes of communication and coordination of activities****. Furthermore, organizational learning is a dynamic activity, not only as an internal activity but also as a result of the assimilation and use of* ***knowledge*** *generated* ***outside the firm.****"(pp.213-214)*

2006	2006 Zahra, Sapienza, and Davidsson	Entrepreneurship and dynamic capabilities: A review, model and research agenda.	Journal of Management Studies, 43(4), 917-955.	*"…dynamic capabilities are affected by and transform substantive capabilities and the firm's knowledge base. Together, the **substantive capabilities** and the firm's knowledge base directly and **interactively affect** the organization's performance. Finally, performance results affect future entrepreneurial choices." (p.8)* *"…substantive capabilities are embedded in what the firm does and how it does it." (p.9)*
2007	Wang and Pervaiz	Dynamic Capabilities: A Review and Research Agenda.	International Journal of Management Reviews 9 (1): 31–51.	*"…the firm's resources and capabilities in relation to environmental changes and that allow for the identification of firm-specific or industry-specific processes that are critical to the firm's evolution." (p.10)* *Hence, capabilities are often firm-specific and are developed over time through **complex interactions** among the firm's resources." (p.11)*
2009	Bowman and Ambrosini	What are dynamic capabilities and are they a useful construct in strategic management?	International Journal of Management Reviews, 11, 29—49.	*"…the **top management team** and its beliefs about organizational evolution may play an important role in developing dynamic capabilities." (p.2)* *"The 'dynamism' relates to how the resource base changes in a new context conditions through the use of dynamic capabilities. The dynamism consists **in the interaction** of the dynamic capability and resource base, allowing their modification respectively." (p.8)*
2009	Easterby-Smith, Lyles, and Peteraf	Dynamic capabilities: Current debates and future directions.	British Journal of Management, 20(s1), S1-S8.	*"The operational mechanisms that influence new process development are rooted in knowledge articulation and knowledge codification, and these reflect managerial decisions. Knowledge articulation can include managerial decisions to have functionally **diverse teams**, which may include co-location strategies to improve learning and problem-solving performance." (p.S5)* *"…dynamic capabilities can take a variety of forms and involve different functions, such as marketing, product development or process development, but the overriding common characteristics are that they are higher level capabilities which provide opportunities for knowledge gathering and sharing, continual updating of the operational processes, **interaction** with the environment, and decision-making evaluations." (p.S7)*
2009	Arend and Bromiley	Assessing the dynamic capabilities view: spare change, everyone?.	Strategic Organization 7(1) 75-90.	*"Scholars who examine organizational change generally agree that a variety of firm behaviors **interact with the firm's condition and environment** to influence the likelihood of performance-enhancing change." (p.82)* *"The dynamic capabilities concept thus suggests greater tangibility and coherence in desirable features than the reality of complex, **interacting firm behaviors**. Firms may have the ability to do things they do not frequently do." (p.83)*
2010	Barreto I.	Dynamic capabilities: A review of past research and an agenda for the future.	Journal of Management, 36(1), 256—280.	*The dynamic capabilities approach was built around "…several main elements that highlight its major theoretical underpinnings (nature, role, context, creation and development, outcome, and heterogeneity)."* *"…specified the desired end (i.e., the role) of this special capability as being **to integrate (or coordinate)**, build, and reconfigure internal and external capabilities. Herein,* [Teece et al. (1997: 516)] *they assumed an evolutionary economics perspective (Nelson & Winter, 1982) by enunciating the role of routines, path dependencies, and organizational learning."(p.4)*
2010	Di Stefano, Peteraf, and Verona	Dynamic Capabilities Deconstructed. A bibliographic investigation into the origins, development, and future directions of the research domain.	Industrial and Corporate Change, 19(4), 1187-1204.	*Not mentioned*
2012	Giudici and Reinmoeller	Dynamic capabilities in the dock: A case of reification?	Strategic Organization, 10(4), 436-449.	*Not mentioned*

2013	Vogel and Güttel	The dynamic capability view in strategic management: A bibliometric review.	International Journal of Management Reviews, 15(4), 426-446.	*"Streamlining research in this field would lead to a better understanding of the micro-foundations of dynamic capabilities. It would also help elucidate the field's central theoretical concept, and thus consolidate the field's identity, by drawing on (a)* ***the interaction*** *between top-management cognition, (b) strategic decision-making and (c) routines and practices for reconfiguring the firm's resource base." (pp.441).*
2013	Peteraf, Di Stefano, and Verona	The elephant in the room of dynamic capabilities: Bringing two diverging conversations together.	Strategic Management Journal, 34(12), 1389-1410.	*Not mentioned*
2013	Wilden, Devinney, and Dowling	The Architecture of Dynamic Capability Research: A Scientometric Investigation.	Academy of Management Proceedings (Vol. 2013, No. 1, p. 11807	*Not mentioned*
2014	Eriksson T.	Processes, antecedents, and outcomes of dynamic capabilities.	Scandinavian Journal of Management, 30(1), 65-82.	*"Most of the studies conceptualizing Dynamic Capabilities as specific processes focus on product or technology development and transfer, although some* ***emphasize inter-organizational collaboration*** *and capability acquisition, organizational restructuring or business-model adaptation" (p.69).* *"Firms use various knowledge-integration strategies, many of which rely on* ***organizational interaction and collaboration routines****." (p.70)* *"In analytical terms it is connected to absorptive capacity in that organizations with such capacity are better able to make use of the knowledge at their disposal. The* ***sharing of tacit knowledge,*** *in particular, is* ***essential in the interaction between individuals.*** *Therefore, overcoming communication barriers is vital for knowledge utilization." (p.70)*
2016	Wilden, Devinney, and Dowling despite considerable academic interest, there are many questions about what dynamic capabilities (DCs	The Architecture of Dynamic Capability Research Identifying the Building Blocks of a Configurational Approach.	Academy of Management Annals, 10(1), 997-1076.	*Dynamic Capabilities are essentially a multilevel phenomenon spanning individuals,* ***groups [teams],*** *business units, organizations, and alliances, and that much of* ***the definitional confusion arises from a failure to account for the interactions across levels and between contexts****."(p.1027)*

Hence, collaboration under the dynamic capabilities framework emerges from the interaction and build-up of experience, skills and technical knowledge processes (Deeds et al., 2000), and depending on the firm's activity, it means based on "what the firm does and what it does it with" (Zahra et al., 2006); it involves changes in their environment that encourage the organization to evolve (Wang & Ahmed, 2007); and entails a coordinated and active organizational condition of interaction with its context (Easterby-Smith et al., 2009). Hence, the organizational shift––dynamic capability––is fostered through the interaction of the firm's internal operational conditions with its context; in sum, through the tangibility of resources and consistency of continual efforts according to the circumstances (Arend & Bromiley, 2009). Dynamic capabilities integrate internal and external collaboration activities in different dimensions of the firm, related to its operations, goals, context, processes of creation, development and outcome, by including the stakeholders in its ecosystem (Barreto, 2010). Finally, dynamic capabilities provide the framework for the understanding of a multilevel phenomenon that (1) arises from the interplay between top-management cognition, strategic decision-making and the incentive of flexible routines and coordinated practices (Vogel & Güttel, 2013); (2) emphasizes intra-organizational (internal) and inter-organizational (external) collaboration through routines that allow the exchange of knowledge (Eriksson, 2014); and (3) is influenced by the context of the technology-based startup (Wilden et al., 2016).

Technology-based startup teams, as a social group, require the collection and integration of diverse activities and functions to consolidate the organization of the technology-based startup. These activities and functions can be exchangeable and specific, where each team member undertakes tasks that are distributed for operational purposes. For instance, in R&D, new product development routines and quality control routines are shared and distributed among the available team members (Eisenhardt & Martin, 2000)

The interaction among the members of the technology-based startup is crucial for its entrepreneurial activities and dynamic capabilities

strategy. The team's dynamics support the perspective of harnessing the creativity and knowledge of each team member within the context of the startup. In this context, routines are predetermined, repetitive, specific, and standardized activities, such as those performed in production processes; interactions are more related to connectivity and coordinated contact (networking) with two or more members, taking into account their levels of intensity and frequency. Finally, sentiments are emotions, motivations, and attitudes that derive in the generation and adoption of knowledge and skills that cannot be measured but can have an impact upon both activities and interactions (Loasby, 2006).

When technology-based startup teams interact with their context, particular synergies are enabled among their members, and these forces create new inputs and processes (Ilgen et al., 2005). Technology-based startup teams usually arise from interactions among individuals with a background in high-technology industries (Vyakarnam et al., 1999). Their innovation functions and activities are closely related to the identification of opportunities for wealth and value creation. The technology-based startup teams' entrepreneurship activities require the willingness to identify opportunities by testing and checking processes and using their available resources efficiently. These conditions enable them to pursue a fast-track and dynamic adaptation and evolution of the team's organization by following the 'lean' concept (Ries, 2011). This adaptability and flexibility allow technology-based startup teams to work as an intermediary driver between the knowledge available and economic agents in the market.

3.2 Team collaboration capabilities

Collaboration capabilities support and strengthen organizational capabilities throughout the innovation process by improving the organization's performance. Collaborative capabilities are oversimplified under the dynamic capabilities approach, due to their interdependence with the company's internal resources. Collaboration in an organization focused on innovation involves the integration, coordination, and continuity of output-input activities between two or more actors (Blomqvist & Levy, 2006). In contrast, capabilities in technology-based startups are a high-level routine or a set of routines developed for strategic purposes (Winter, 2003). Innovation is the result of collective and coordinated efforts produced by integrating and cross-leveling group interactions.

The team 'management performance' is an 'input-process-output' condition, characterized by a combination of autonomy, flexibility, mutual support, discipline, and trust among the team members. The manager needs to develop a high level of integration with the team. Collaborative capabilities consist of information processing, communication, knowledge transfer and control, where coordination, reliability or the ability to generate trust, and negotiation skills are vital (Blomqvist & Levy, 2006, p.34). The team's members are vehicles of external and internal knowledge, produced and acquired through sharing in continuous interaction, and subsequently influencing the operational functions of the technology-based startup.

Team collaboration capabilities refers to the organization of technology-based startups, and centers on intra-organizational relationships at diverse levels of responsibility. It is a multidimensional concept comprising several levels of intra-team interaction, namely, individual (face-to-face), the team (a group of individuals), intra-firm coordination, and organizational collaboration for innovation (Blomqvist & Levy, 2006). The interaction of team collaboration capabilities is also related to multidisciplinary teams, also known as cross-functional teams, which are more widely recognized in large companies and top team management activities, and involve collective and diverse efforts. Cross-functional teams "comprise a group of people representing a variety of [areas,] departments, disciplines, or functions, whose combined efforts [aim] to achieve the team's purpose". Once "[…]cross-functional teams [are effective, they] can speed up product development and turnaround on customer requests, improve the organization's ability to solve complex problems, serve as a vehicle for organizational learning and act as connecting points of contact for projects" (Wang & He, 2008, p. 753). The effectiveness of cross-functional teams depends on the interaction of a set of activities that facilitate learning, knowledge production, problem-solving and networking.

Most technology-based startups focus on international markets, and therefore collaboration in building new capabilities quickly is vital for their survival. Nevertheless, the conditions for building capabilities do not reach the same level of intensity and dynamic because other factors such as internal functions and needs must be considered and met. According to Zahra et al. (2006), the capabilities to transform and create new capabilities, dynamic capabilities, for innovation performance reside in the technology-based startup's origin, history and goals. Zahra et al. (2006) also identify the importance of the expertise and skills of the team's founder members as the key source of innovation, particularly if they contribute to transforming resources, considered as 'notably managerial resources' to foster new capability building. Dynamic capabilities therefore depend on the team's 'substantive capabilities' or operational capabilities, grounded in new additional knowledge as a result of the collective interaction of team members, based on the knowledge, activities and decision making linked to the strategy (Eisenhardt & Martin, 2000; Zahra et al., 2006). The team's collaboration capabilities are their substantive ability to produce and support operative capabilities focused on, for example, new product development or distribution capabilities (Winter, 2003).

Team collaboration capabilities lie in the management and team members, through interaction and integration among the rest of the team members. The integration of the team allows the right combination of different skills and helps overcome resistance to change among members for organizational flexibility. (Clarke Højbjerg et al., 2014). Team collaboration capabilities link to the operational capabilities and encourage their continual improvement by adding high levels of new routines, and fast-tracking the configuration of new capabilities. Once operational activities are consolidated, operational capabilities continue to improve through dynamic capability building. However, they are a consequence of the unique idiosyncratic effects of the firm, namely the active willingness to learn and to adapt to new circumstances, even in highly dynamic environments.

4. Conclusions and future research

The main objective of this paper was to explore the role of intra-collaboration functions as necessary conditions for dynamic capability building in technology-based startups. Through a combination of various literatures, we have articulated and exposed the term 'team collaboration capabilities' to describe the intra-organization collaboration sources required among the team members of technology-based startups. In light of our review, we propose a new definition of technology-based startups as follows: a technology-based startup is an organized team of two or more entrepreneurs with technical and/or scientific training, who share knowledge, responsibilities and active participation in the configuration of a team, from which new ideas are generated and responsibility is shared in taking operative and strategic decisions in order to sustain the organization in the long term.

Team collaboration capabilities incorporate the natural grouping of ideas and personal beliefs that team members have in common. The technology-based startup team is well characterized by important social and knowledge capital. From their beginning technology-based startup teams are made up of social capital that interacts with organizational assets and relational complementarities, for example, their personal relationships and professional networking activities. Moreover, a technology-based startup team implies knowledge heterogeneity and an organizational structure in their daily activities; this involves combining human capital with formal and informal connections for specific purposes. Together, these constitute a unique and differentiated firm structure defined by the technology-based startup team members' background and idiosyncrasies. The technology-based startup team's organization and operations forge each experience, knowledge, and skills to shape team expertise. The way in which individuals consistently work together defines, in part, the organization and its operational capabilities.

Dynamic capability building in technology-based startup teams is enabled through willing and positive behavior and the series of constant interactions that take place in team collaboration capabilities. They should produce good organizational outcomes as long as they work together and combine their individual skills. The technology-based startup team's activities, together with their coordinated interaction, are entrepreneurial components of their organization, which constitute drivers oriented to mobilizing the available resources, spotting new opportunities and assessing potential markets. Therefore, team collaboration capabilities engineer operational routines that together constitute the technology-based startup teams' dynamic capabilities.

We have attempted to bridge a gap in the literature on the internal processes of technology-based startup teams and their members' interaction in order to further current knowledge on dynamic capability building. This study represents an initial solid step to define a roadmap of the complex knowledge and recognition of team collaboration capabilities as a concept that describes the intra-team organizational conditions of the technology-based startup to support their role in innovation processes.

This study of technology-based startups has implications both for future research and for managers and investors (public and private). The main implications of this review lie in contrasting the dynamic capabilities approach with definitions of technology-based startups; although most of the papers reported were published in gray literature from the 1980s and 1990s, we also found several academic papers based on theoretical studies. In this respect, the technology-based startup team represents a co-evolutionary form of organization. Technology-based startup teams have a particularly dynamic organization that is highly ambivalent; it is a combination of independent and interdependent, an uncertain, fragile and dynamic form of organization. Within the organizational context of technology-based startups, the central agent is the interaction among the team's members, whose collaboration capabilities drive the firm's dynamic capabilities. Directions for future research include studies to provide a detailed analysis and assessment of team collaboration capabilities, considering the general interest of technology-based startups as unique and diverse organizations in continual adaptation.

Acknowledgements

We are grateful to the Consejo Nacional de Ciencia y Tecnología de México (CONACyT) for funding Anna Karina Lopez-Hernandez's Ph.D. research grant. We also thank the Conselleria d'Educació, Investigació, Cultura i Esport (GV/2018/003) for financial support for this research. We are indebted to Pablo D'Este for his detailed and insightful feedback.

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ISSN: 0718-2724. (http://jotmi.org)

Innovation studies in Latin America: a bibliometric analysis

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Abstract: The article's objective is to present a quantitative overview of innovation studies developed by Latin American authors. We adopted the bibliometric method to build the study, with data originated from the Scopus and Web of Science databases, covering 30 years (1987-2016). From this data analysis, we found out that innovation studies in Latin America, for long period, did not present a significant volume. However, this scenario has undergone changes, such as: (1) the growth in the volume of publications of the countries; (2) the relevant collaboration between Latin American countries and the United States, Spain, and the United Kingdom; (3) and relevant presence of Brazilian authors and universities as the most productive in the region. Despite these changes, Latin America still falls behind the reference countries in the area, accounting for 2.75% of the worldwide bibliographic production on innovation in the databases analyzed.

Keywords: innovation studies; bibliometric analysis; Latin-America; Scopus; Web of science

Submitted: May 29th, 2018 / Approved: November 6th, 2018

Introduction

In academia, the term innovation emerged with the pioneering work of Joseph Schumpeter entitled "The Theory of Economic Development". After this theoretical contribution, for a long time, little interest was devoted to innovation studies and works on the field was sporadic (Fagerberg et al., 2011). Nevertheless, after the 1950s decade, due to the theoretical and empirical contributions of several scholars (Solow, 1957; Freeman, 1974; Rosenberg, 1976; Nelson & Winter, 1982; Pavitt, 1984; Dosi, 1982; Teece, 1986; Lundvall, 1992; Christensen, 1997; etc.), such scenario started to change.

Currently, innovation studies are a prominent research field (Fagerberg & Verspagen, 2009) driven by the increase in the number of business schools and researchers interested in innovation and innovation-related topics, in addition to the stimuli caused by the growing demand for a greater comprehension of the nature of innovation processes for policy and management purposes (Martin, 2016).

Originally named as science and technology studies (Godin, 2014), innovation is a multidisciplinary research field formed by disciplines such as economics, management, political science, organizational science, technology, and innovation, which gather to generate knowledge for the economic development and growth (Martín, 2016; Solow, 1957; Schumpeter, 1911). Therefore, with the aim to advance towards the consolidation of this research field, a set of studies has emerged to characterize this area of knowledge and to point different perspectives and challenges. In the world literature as a whole, this information is available due to different bibliometric studies (Fagerberg & Verspagens, 2009; Fagerberg et al., 2012; Sun & Grimes, 2016).

In Latin America, innovation studies have been carried out with some lag when compared to the United States and Europe and, although in the 1970s decade some authors (Sábato, 1971; Sagasti, 1973; Perez, 1986; Katz, 1984) started to conduct initial studies on innovation, the research area only gained momentum at the beginning of the 21st century. Besides the lagging, except of the studies of Ketelhöln and Ogliastri (2013), Lazzarotti, Dalfovo and Hoffmann (2011), Olavarrieta and Villena (2014) and Zawislak, Tello-Gamarra, Fracasso and Castellanos (2017), a lack of research can be noticed on the identification and characterization of innovation studies in Latin America.

With the aim to assist literature fulfilling this gap, this article's objective is to analyze innovation studies in Latin America, seeking to identify a set of quantitative information from these studies. We adopted the bibliometric method to build the study. The results provide an overview of Latin-American scientific production on innovation studies and, consequently, it provides decision-making bases for innovation policies, in light of the recognition of innovation as an essential condition for the economic progress of regions (Freeman, 1974). Such information enabled the identification of the academic production volume during the thirty years analyzed, the countries that collaborate outside the region and the most productive universities. Also, we analyzed the most frequently published journals, types of documents, most productive and cited authors and the most used languages for publication.

Thus, the structure of this article is divided in 4 more sections. Section 2 presents the literature review, which aims to discuss the development of innovation around the world and to present the most prominent Latin-American studies. Afterward, in Section 3, we present the method applied and we explain the steps followed to obtain the results. Finally, in Section 4, we present the quantitative results found and, finally, we discuss the findings in Section 5, where we also present the limitations and the practical implications derived from this study.

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ISSN: 0718-2724. (http://jotmi.org)

Literature Review

The first innovation definition was proposed by Joseph Schumpeter (1911) in his work "The Theory of Economic Development," where the author associated innovation to the economic development and defined it as a new combining way of productive resources. This work, initially launched in German and later translated into English, established specific types of innovation, such as the introduction of new products, new production methods, the exploration of new markets, new supplying sources and new methods of industrial organization. Also, the author pointed that the relationship between innovation and economic development was due to breaks in an economic equilibrium, where the ruptures were waves that came to destabilize the existing equilibrium. Moving forward in his studies, Schumpeter (1942), in his book "Capitalism, Socialism, and Democracy," coined the term "creative destruction". This term is based on the fact that companies introduce new goods and production processes in order to make existing technologies obsolete, and therefore, take over the market of the companies that were not capable of introducing new goods and production processes. In this sense, one of the foundations that compose capitalism is the destruction of the old for the emergence of the new, the innovation.

Schumpeter's studies catalyzed new contributions to the theme. Some of these contributions came from Christopher Freeman, who followed the Schumpeterian assumptions about the role of innovation in economic and social change. In his book "The Economics of Industrial Innovation" published in 1974, Freeman sought to reveal the characteristics of the technological strategies adopted by the companies. Also, Freeman's contribution is relevant because it highlights the need to standardize innovation indicators and stimulate scientific research. The emphasis on the need for uniformization comes from works that sought to standardize innovation indicators, such as the Frascati Manual and the Oslo Manual, collaborating to determine guidelines and policies in the measurement of innovation internationally (Lazzarotti, Dalfovo & Hoffmann, 2011). On the other hand, the stimulus to the development of scientific research is due to Freeman's recognized characteristic as a social science entrepreneur (Fagerberg et al., 2011), since he funded the unit of innovation studies SPRU (Science Policy Research Unit), in the University of Sussex, in 1965, which served as a model for several innovation study centers worldwide. This initiative attracted a vast number of researchers from several countries who saw in SPRU and Freeman the opportunity to develop research in this area.

In addition to Schumpeter and Freeman, several other authors had innovation as the central issue in their work. Robert Solow (1957) suggests that economic growth is due to technology improvement, contrary to the perspective of capital accumulation. Nathan Rosenberg (1976) focused his research on technological, institutional, and economic evolution, which allowed the development of more systematic analyses of innovation. Nelson and Winter evidenced in their work "An Evolutionary Theory of Economic Change" published in 1982, that companies are inserted in routines, creating trajectories in which they cumulatively develop knowledge on how to perform their activities. These routines hold them in certain trajectories making it difficult to exit, explaining, in the authors' view, why some firms are capable of innovate and why others are not. At the same level of relevance, Edith Penrose, in her work "The Theory of the Growth of the Firm" published in 1959, emphasizes that innovation depend on the new viable resources and capabilities whose operation adds new value to the existing circular flow of income, creating new profits and incomes.

Furthermore, Giovanni Dosi (1982), following the precepts of Nelson and Winter (1982), in his work "Technological Paradigms and Technological Trajectories" suggests that there are "technological paradigms" which are structured, standardized, and cumulative set of technological knowledge, innovative opportunities, and productive patterns. Furthermore, David Teece (1986) sought to explain in his work "Profiting from Technological Innovation" why some firms, although innovative, frequently fail to obtain a significant economic return. Keith Pavitt (1984) focused on the technical change strand, by creating sectorial taxonomies to classify industrial sectors, which are: supplier dominated, production intensive, and science-based. Clayton Christensen (1997) described how disruptive technologies undermine the competitive position of an established company by offering a cheaper and sufficiently good technological alternative for most of the clients. Lundvall (1992) states that innovation does not happen isolated, but in a holistic perspective, highlighting the role of interactions between organizations, the government, and universities, that is, the National Innovation System.

By focusing on Latin America, authors such as Jorge Sábato (1971), Francisco Sagasti (1973) Carlota Perez (1986) and Jorge Katz (1984) contributed with works in this area. Sábato (1971) relates the role of technology allied to science, developing a political, scientific, and technological model, the Sábato Triangle, where he tries to describe the three elements that are, historically, fundamental to the development of science and technology (government, the productive industry, and the scientific and technological infrastructure). The author argues that these elements must work in a coordinated way aiming to develop technological innovations in the national context. Sagasti (1973) examines the interrelationship between underdevelopment, science, and technology, claiming that the way science and technology developed in the twentieth century contributed to underdevelopment. On the other hand, Perez (1986) emphasizes that the notion of technological determinism not imply patterns of technological trajectories, since the technological paradigm offers ample space and, within this, also includes social forces, experiences, and institutional arrangements that shape, guide, select, and regulate the final course of the trajectories, possibly giving new potentials to these trajectories. Katz (1984) analyses the key factors affecting the acquisition of technological capabilities by industries in the least developed countries. He also identifies that much of the productivity increase comes from process optimization efforts, and the planning and organization of the production by adapting and improving existing technologies. Despite the importance of the contribution of these scholars, there is currently no bibliometric research on innovation studies in Latin America.

Method

This study is a bibliometric analysis, which has been used by many authors in a range of disciplines, including innovation. According to

Bjork et al. (2014), bibliometric studies are useful when seeking generalized views of a research field and also to analyze the researchers. Thus, Sun and Grimes (2016) state that the bibliometric method is used to compare scientific activities to their different levels, including institutions, countries, and journals. In this sense, Boyack et al. (2002) argued that the bibliometric approach can be classified as follows: (1) a macro research plan that aims to define the structural units of science and their interrelations on a global scale; and (2) a micro research plan characterized by an attempt to establish knowledge within a specific disciplinary domain and, thus to inform its state of the art.

Therefore, this article is characterized as a micro bibliometric analysis, seeking to verify the publications of a specific field of knowledge, innovation, in the Latin American scope. To reach this result we sought to identify: (1) the evolution of the publications during the established period; (2) the number of publications of each Latin American country; (3) the number of citations of these works; (4) the authors; (5) the countries of residence of the authors who participated in these works; (6) the journals that published these works; (7) the affiliations of these authors; (8) the language of the published works; (9) the type of document; (10) the top countries publishing in the theme.

Moreover, we also sought to (11) the index resulting from the division of the citation number by the number of publications; and, finally, (12) the index resulting from the division of the number of citations by the number, in millions, of inhabitants in each country. These indices are relevant because they help to provide an analysis of the scientific production of a given area (Bonilla et al., 2015). Therefore, we chose the P/Pop (number of publications divided by the number of the country's population) to verify how many articles are published by each inhabitant of the region and, also, the C/P index (citations divided by the total number of publications) to verify the impact of these articles.

To obtain this information we used, in July 2017, two databases: Scopus and Web of Science. In the Scopus database, we searched the words "innovation", "technical change" and "technological change" in the three most used languages for scientific publication in Latin America: English (innovation, technical change, and technological change), Portuguese (inovação, mudança técnica and mudança tecnológica) and Spanish (innovación, cambio técnico and cambio tecnológico). The terms "technical change" and "technological change" were used as synonyms to the word "innovation" because literature also addresses them in such forms. Moreover, we observed that the terms "technical change" and "technological change" are more frequently used by researchers in the field of economics and the term "innovation" in business. Thus, we searched the terms on the three languages using the logic operator "or" so that the database would search for any of the words in the "title," "keywords," or in the abstract of the publications. Also, filters were added in order to limit the period of analysis, a field of study and countries of publication. For the analyzed period, we selected the publications of the last thirty years, that is, from 1987 to 2016, filtering for the research fields of "Business, Management and Accounting" and "Economics, Econometrics, and Finance." Regarding the countries, all Latin American countries were selected, according to OECD (2017).

In the Web of Science database, we also searched for the words "innovation," "inovação" and "innovación," using the logic operator "or" to search the terms in "Topics," the database equivalent to "Title," "Keywords" and "Abstract." From the result of this first stage, we used the same filters used in the Scopus database, however for the field of study we filtered the field for "Business," "Economics" and "Management." As the objective of this work is to identify studies on innovation in Latin America, we only considered the studies that had some affiliation to Latin American countries, not considering in this scope, the studies of innovation written by researchers born in the region but with affiliation to some foreign institution.

Result

Evolution of research in Latin America

During the last years, some countries in Latin-America experienced a representative economic growth, which has significantly contributed to the increase of research in these countries (Bonilla et al., 2015). Thus, when we analyze the number of published research on the theme innovation, this growth happened in a significant way after 2006, reaching in that year, the mark of 55 published documents in Scopus and 17 in the Web of Science database. A comparison, in 2005, Scopus presented 22 publications whereas Web of Science presented 8, that is, publications doubled between the two years in both databases. Moreover, publications in Latin America did not exceed 203 documents in the Scopus database, while in the Web of Science it reached 140 from 1987 to 2005.

Fig. 1 Total number of published documents on the innovation theme (1997 – 2016)

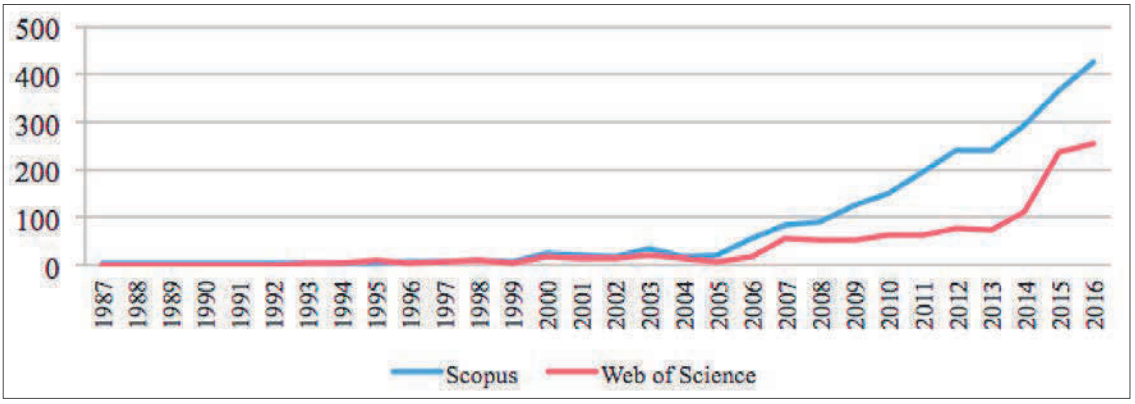


Figure 1 shows that after 2006, there is a growth in publications in both databases, reaching a mark in 2016 of 426 documents published in Scopus and 254 documents published in Web of Science. Furthermore, in 2016 alone, the sum of the articles published by both databases was more than the double of the articles published within the 1987-2005 period (Figure 1).

Most productive Latin American countries

After we verified that, in their entirety, studies are in full growth in the region, we found it necessary to analyze how much each Latin American country is publishing. Thus, in the Scopus database, Brazil leads innovation studies totaling 1,373 publications in the last 30 years with 5,471 citations. Other data regarding Brazil refers to the indicators of citation quantity divided by the total of publications (C/P) and the number of publications divided by country's population in millions of inhabitants (P/Pop). In these indicators, the country had a C/P indicator of 3.98 and 6.60 of P/Pop.

Following Brazil, in the Scopus database, Mexico presents 317 publications, followed by Colombia with 233 and Chile with 201. Thus, in the face of the total number of papers published during the analyzed period, Mexico had 1,970 citations, Colombia 1,014, and Chile 1,492. Also, these countries also present C/P indices of 6.21 and P/Pop of 2.48 for Mexico, 4.35 and 4.76 for Colombia and 7.42 and 11.17 for Chile. It is important to highlight that the C/P index (citation per publication) presented by these countries is superior to that of the leader in Brazil. In other words, Mexico, Chile, and Colombia publish less in absolute numbers, though the articles published by these countries have more citations than those published by Brazilian authors. In addition to these countries, Uruguay also presents C/P and P/Pop indices higher than the Brazilian ones: 5.11 and 12.86 respectively. Table 1 presents this information.

Table 1 Latin American countries with the higher number of publications on the theme innovation according to SCOPUS (1987-2016)

Scopus						
Rank	**Country**	**Number of publications**	**Number of citations**	**C/P**	**Population (millions)**	**P/Pop**
1	Brazil	1,373	5,471	3.98	210.8	6.51
2	Mexico	317	1,970	6.21	130.8	2.42
3	Colombia	233	1,014	4.35	49.5	4.71
4	Chile	201	1,492	7.42	18.2	11.04
5	Argentina	262	736	2.81	44.7	5.86
6	Peru	56	311	5.5	32.5	1.72
7	Venezuela	50	136	2.72	32.4	1.54
8	Uruguay	45	230	5.11	3.5	12.86
9	Costa Rica	25	199	7.96	5	5.00
10	Ecuador	24	123	5.13	16.9	1.42
11	Cuba	16	29	1.81	11,5	1,39
12	Trinidad and Tobago	14	134	9.57	1,4	10,00
13	Bolivia	11	240	21.82	11.2	0.98
15	Jamaica	10	79	7.9	3	3.33
16	Barbados	7	71	10.14	0.3	23.33
17	Puerto Rico	4	19	4.75	3.7	1.08
18	Nicaragua	3	28	9.33	6.3	0.48
19	Dominican Republic	2	4	2	11	0.18
20	Guatemala	2	87	43.5	17.2	0.12

Note: C/P: citation per publication; P/Pop publication divided per country population; Population (millions) extracted from The World Bank (2018); Latin American countries according to the classification proposed by OECD (2017).

In the Web of Science database, Brazil also occupies the first position with a total of 550 publications, 2,889 citations, 5.25 C/P and 2.64 P/Pop index, followed by Mexico with a total of 172 publications, a C/P index of 7.15 and a P/Pop index of 1.34, Colombia with 142 publications, 3.94 C/P and 2.90 P/Pop and Chile with 142 publications, 9.16 C/P and 7.89 P/Pop.

It should also be noted that the same phenomenon that occurred in the Scopus database was observed the Web of Science database, where countries ranked below surpassed the leader Brazil in the C/P index, however with one caveat: in this index, considering Web of Science database, Colombia scored lower than Brazil. Table 2 presents this information.

Table 2 Latin American countries with the higher number of publications on the theme innovation according to Web of Science (1987-2016)

Web of Science						
Rank	**Country**	**Number of Publications**	**Number of Citations**	**C/P**	**Population (millions)**	**P/Pop**
1	Brazil	550	2,889	5.25	210.8	2.61
2	Mexico	172	1,230	7.15	130.8	1.34
3	Colombia	142	559	3.94	49.5	2.9
4	Chile	142	1,301	9.16	18.2	7.89
5	Argentina	86	729	8.48	44.7	1.95
6	Peru	28	207	7.39	32.5	0.88
7	Uruguay	24	102	4.25	3.5	6.86
8	Costa Rica	24	76	3.17	5	4.8
9	Ecuador	16	81	5.06	16.9	0.98
10	Venezuela	14	40	2.86	32.4	0.44
11	Trinidad and Tobago	9	85	9.44	1.4	6.43
12	Nicaragua	8	21	2.63	6.3	1.31
13	Bolivia	8	156	19.5	11.2	0.73
14	Cuba	7	6	0.86	11.5	0.61

Note: C/P: citation per publication; P/Pop publication divided per country population; Population (millions) extracted from The World Bank (2018); Latin American countries according to the classification proposed by OECD (2017).

Aiming to compare the countries with the higher number of publications on the innovation theme worldwide, we performed a new search in the two databases (Table 3). Globally, the countries that stand out publishing on the theme, in Scopus, are the United States with 16,933 publications, followed by the United Kingdom with 8,295 and China with 6,349 publications. On the other hand, in the Web of Science database, the United States stands out with 13,712 publications, followed by China with 9,264 and England with 5,786 publications. It is worth mentioning that Brazil was the only Latin American country figuring among the top twenty countries with the higher number of publications worldwide, presenting 1,373 publications in Scopus. Nevertheless, in the Web of Science database, Brazil is not in the top 20.

Table 3 Countries with the higher number of publications on innovation globally (1987-2016)

	Scopus				Web of Science			
Rank	**Country**	**Number of Publications**	**Population (millions)**	P/Pop	**Country**	**Number of Publications**	**Population (millions)**	**P/Pop**
1	United States	16,933	326.5	51.9	United States	13,712	323.2	42.43
2	United Kingdom	8,295	66.6	124.5	China	9,264	1415	6.55
3	China	6,349	1,415	4.5	United Kingdom	5,786	66.6	86.88
4	Germany	4,329	83	52.2	Germany	2,901	83	34.95
5	Italy	3,370	59.3	56.8	Italy	2,620	59.3	44.18
6	Netherlands	3,029	17.1	177.1	Netherlands	2,478	17.1	144.91
7	Spain	2,899	46.4	62.5	Spain	2,416	46.4	52.07
8	Australia	2,868	24.8	115.6	Canada	2,076	37	56.11
9	France	2,740	65.2	42.0	France	1,892	65.2	29.02
10	Canada	2,511	37	67.9	Australia	1,741	24.8	70.20
11	Taiwan	1,757	23.7	74.1	Taiwan	1,438	23.7	60.68
12	Switzerland	1,607	8.5	189.1	Sweden	1,266	10	126.60
13	Finland	1,392	5.5	253,1	South Korea	1,001	51.2	19.55
14	India	1,386	1,354	1.0	Finland	993	5.5	180.55
15	Brazil	1,373	210.8	6.5	Japan	883	127.2	6.94
16	Japan	1,260	127.2	9.9	Denmark	856	5.7	150.18
17	Sweden	1,111	10	111.1	Romania	844	19.6	43.06
18	Denmark	1,096	5.7	192.3	Switzerland	824	8.5	96.94
19	Russia	1,004	144	7.0	Belgium	720	11.5	62.61
20	South Korea	1,003	51.2	19.6	Portugal	611	10.3	59.32

Note: P/Pop Publication divided per country population; Population (millions) extracted from The World Bank (2018).

By way of comparison, in Scopus, Latin America presents 3.3% of the world publications, wherein the top one country, United States, alone presents 22.56% of the world's publications. In the Web of Science database, while Latin America presents 2.2% of the world's publications, the United States represents 25.4% of these publications.

Collaboration between countries

Another point observed refers to the countries worldwide that are making partnerships with the region, that is, the non-Latin American countries with the highest co-authorships with Latin American authors (Table 4). According to the Scopus database, among the countries that stand out by the number of co-authorships are the United States, followed by Spain and, in third place, the United Kingdom. In the Web of Science database, the United States ranks first, followed by Spain and, in third place, England.

Table 4 Non-Latin American countries with the highest quantity of coauthorships with Latin American countries (1987-2016)

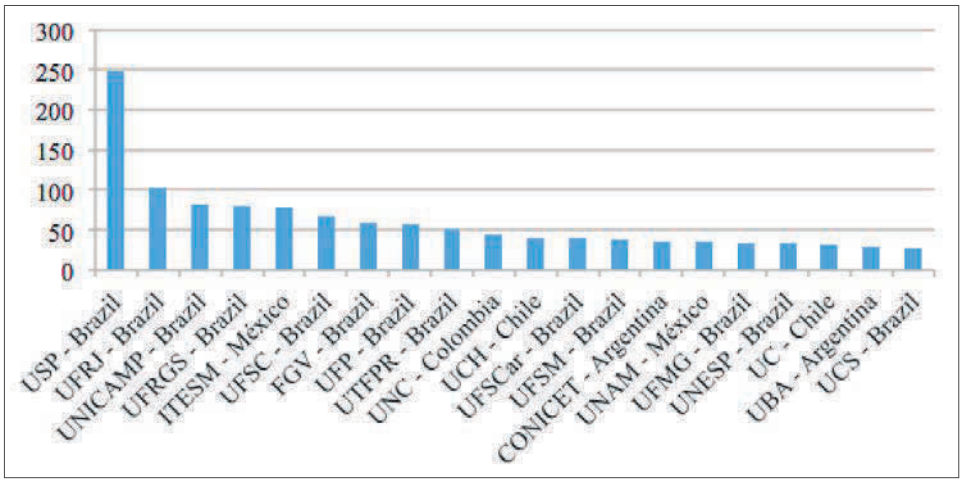
Scopus		Web of Science	
Country	**Number of publications**	**Country**	**Number of publications**
USA	232	USA	146
Spain	155	Spain	124
The United Kingdom	98	The United Kingdom	58
France	60	Italy	36
Canada	51	France	29
Italy	46	Canada	28
Portugal	36	Portugal	20
Netherlands	32	Netherlands	19
Germany	27	Germany	18
Sweden	23	Switzerland	15
Switzerland	15	Sweden	14
Australia	14	Australia	12
China	10	China	8
India	10	Finland	7
Denmark	9	Denmark	7
Finland	7	Belgium	7
Belgium	6	Norway	6
Japan	6	Ireland	6
Norway	6	Scotland	4
South Africa	6	New Zealand	4

In both databases, we found that the USA, Spain, and the United Kingdom account for more than 57% of the co-authorship volume with Latin American countries. This data shows that, despite the relatively low share of Latin America on the worldwide publication volume, the region sets partnerships with leading countries in the subject.

Most productive universities

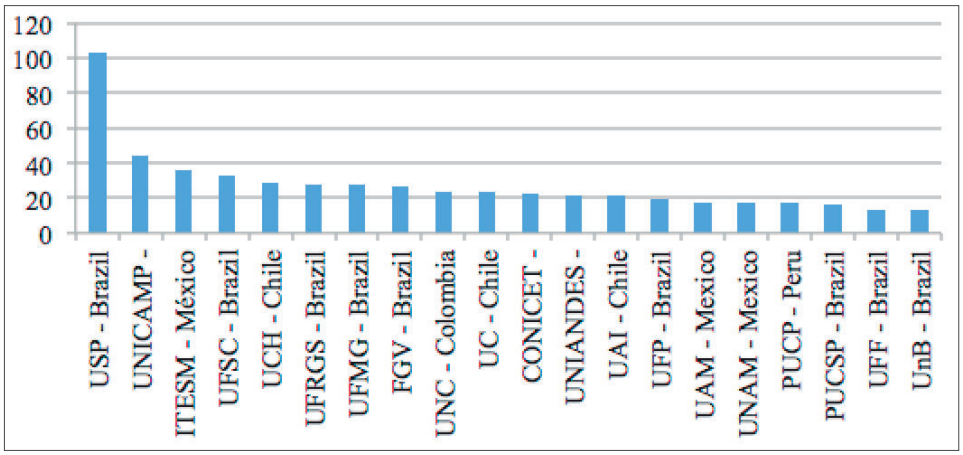
Regarding the institutions that generate such publications, in Scopus, Brazilian institutions stand out and occupy the four top positions with the University of São Paulo, Federal University of Rio de Janeiro, University of Campinas and Federal University of Rio Grande do Sul. The first non-Brazilian university is Tecnológico de Monterrey in the fifth position. It is worth highlighting that among the top twenty publishing universities, 13 are Brazilian universities (Figure 2).

Fig 2 Main publishing institutions - Scopus (1987-2016)



However, in the Web of Science database, Brazilian institutions stand out by occupying the two first positions with the University of São Paulo and the University of Campinas. The first non-Brazilian university is Tecnológico de Monterrey in the third position, followed by Universidad de Chile in the fifth position. Unlike the Scopus database where there were 13 Brazilian universities among the top twenty, in the Web of Science database 10 Brazilian universities are found among the top twenty (Figure 3).

Fig 3 Main publishing institutions – Web of Science (1987-2016)



Document Type and Journals

Additionally, we analyzed the publishing vehicles (Table 5). In the 30 years analyzed, we found that the first publishing vehicle is the document type "Article" with 74%, followed by "Conference Papers" with 13% and "Book chapter" with 8% of the works published in the Scopus database. On the other hand, Web of Science stands out for publishing 78% of articles, followed by the "Conference Papers" with 19%.

Table 5 Types of published documents (1987-2016)

Scopus		Web of Science	
Document Type	**%**	**Document Type**	**%**
Articles	74.00%	Articles	78.00%
Conference Papers	13.0%	Conference Papers	19.00%
Book Chapters	8.00%	Reviews	1.0%
Reviews	3.00%	Book Reviews	1.00%
Book	1.00%	Editorial Material	1.00%
Editorials	0.4%		
Notes	0.2%		
Short Surveys	0.2%		
Articles in Press	0.1%		
	100%		100%

Another information for the paper's objective refers to the journals which were used the most by the authors to publish their works (Table 6). We found that, in the Scopus database, during the researched period, the most used scientific journal was Espacios with a total of 320 publications, followed by the Journal of Technology Management and Innovation with 202 publications and the journal Gestão e Produção with 72 publications. In contrast, in the Web of Science database, the journal with the highest publishing numbers are Revista INTEC with 40 publications, Research Policy with 37 and RAE- Revista de Administração de Empresas with 30.

Table 6 Journals with the highest numbers of publications on innovation (1987-2016)

	Scopus		Web of Science	
Rank	**Journal**	**Number of publications**	**Journal**	**Number of publications**
1	Espacios	320	Revista INTEC	40
2	Journal of Technology Management and Innovation	202	Research Policy	37
3	Gestão e Produção	72	RAE-Revista de Administração de Empresas	30
4	Research Policy	35	Technological Forecasting and Social Change	29
5	Journal of Cleaner Production	32	Revista Brasileira de Inovação	28
6	Technological Forecasting and Social Change	30	Journal of Business Research	27
7	RAE-Revista de Administração de Empresas	29	Science and Public Policy	25
8	Latin America Business Review	24	Technovation	24
9	Revista de Economia e Sociologia Rural	23	Innovar Revista de Ciencias Administrativas y Sociales	20
10	Desarrollo Economico	22	Revista Brasileira de Gestão e Negócios	19
11	Innovar	22	Revista de Gestão e Tecnologia	19
12	Journal of Business Research	22	Revista Latinoamericana de Administración	18
13	Technovation	20	Trimestre Econômico	16
14	Brazilian Administration Review	18	World Development	15
15	International Journal of Innovation and Learning	18	International Journal of Technology Management	15
16	Revista de Economia Política	18	Revista Gestión de las Personas y Tecnologia	13
17	Agroalimentaria	17	Revista de Ciencias Sociales	13
18	Mundo Agrário	17	International Journal of Innovation	12
19	Nova Economia	17	Emerging Markets, Finance and Trade	11
20	Trimestre Econômico	17	Service Industries Journal	10

Most productive authors

Regarding the authors that publish the most (Table 7), we did not find any unanimity between the databases searched. In the Scopus database, the first three positions are occupied by Krugliankas, I. (Brazil), Gomes, C.M. (Brazil), e Sbragia, R (Brazil) each one with 16, 15, and 14 publications respectively. In the Web of Science database, the authors Guevara, A.J.D (Brazil), Figueiredo, P.N. (Brazil) e Bogliacino, F. (Colombia) emerge, each one with 10, 10 and nine publications respectively.

The authors with the highest citation volume identified in the Scopus database are Sutz, J., Cimoli, M., Bogliacino, F. and Figueiredo, P. N., respectively accounting for 185, 91, 90 and 80 citations each. On the other hand, in the Web of Science database, the most cited authors are Vassolo, R. S., Figueiredo, P.N., Boehm, D.M. e Dutrenit, G, each one with 215, 133, 85 and 76 citations respectively. Such data show that there are authors with a large number of publications that, however, do not present a high citation volume, which is the case of Dandolini, G. A. in the Scopus database, and Guevara, A.J.D. and Correa, R.M. in the Web of Science database.

Table 7 Authors with the highest number of publications on innovation (1987-2016)

Scopus				Web of Scinece			
Author	**Country of residence**	**Number of publications**	**Number of citations**	**Author**	**Country of residence**	**Number of publications**	**Number of citations**
Kruglianskas, I.	Brazil	16	44	Guevara, A.J.D	Brazil	10	1
Gomes, C.M.	Brazil	15	22	Figueiredo, P.N	Brazil	10	133
Sbragia, R	Brazil	14	27	Bogliacino, F.	Colombia	9	49
Figueiredo, P.N	Brazil	12	80	Dutrenit, G;	Mexico	8	76
Pilatti, L. A..	Brazil	12	2	Felzensztein, C.	Chile	8	41
Severo, E.A.	Brazil	12	17	Alvarez, R.	Chile	8	56
Sutz, J;	Uruguay	12	185	Porcile, G.	Chile	7	26
Zawislak, P. A.	Brazil	12	69	Pedrozo, E. A.	Brazil	7	3
Bogliacino, F.	Colombia	11	90	Nagano, M.S.	Brazil	7	22
Dutreinit	Mexico	11	58	Cruz, L.B.	Brazil	7	53
Salerno, M.S	Brazil	11	52	Correa, R.M	Brazil	7	1
Scherer, F.L	Brazil	11	13	Reynoso, J.	Mexico	6	59
Jung, C.F.	Brazil	10	6	Lopez, A.	Argentina	6	56
Marx, R.	Brazil	10	22	Boehe, D.M	Brazil	6	85
Vasconcelos, E.	Brazil	10	7	Amorós, J.E.	Mexico	6	77
Borini, F.M.	Brazil	9	49	Zuleta, H.	Colombia	5	22
Cimoli, M. [a]	Italy	9	91	Yoguel, G.	Argentina	5	4
Cassiolato, J.E.	Brazil	8	17	Vassolo, R.S	Argentina	5	215
Dandolini, G.A	Brazil	8	1	Sutz, J.	Uruguay	5	65
Dorion, E.	Brazil	8	19	Santos, F.C.A	Brazil	5	89

[a] Researcher of Universidade de Veneza, Italy, nevertheless, the author researches as a member of the Economic Commission for Latin America and the Caribbean.

Another fact worth mentioning regarding the region's highest publishing authors is the non-appearance of some relevant Latin American authors that research on the theme. Authors such as Jorge Katz, Carlota Perez, Jorge Sábato and Francisco Sagasti do not figure in the ranking from the databases. Four reasons may explain this phenomenon: the publishing vehicle type chosen by these authors, the research themes to which these authors have dedicated themselves in the last 30 years, the emergence of new researchers in this area and the author`s affiliation, who may be associated to universities that are outside Latin America. It is also relevant to note that, in case the authors focus on using "Books" as the means to publish their works, they will be encompassed in the 1% scope of the Latin American publications about innovation, as observed in Table 5.

Most used languages

Finally, we also surveyed the most used languages in the publications. The majority, in both databases, was published in English, followed by Portuguese and Spanish, respectively. One possible explanation for these results may be that the vast majority of the relevant journals on the theme are internationalized, that is, they adopt English as the publishing language and, because of that, they receive greater attention from Latin American researchers. Portuguese is the second most used language for publishing in the region (Table 8).

Table 8 Language of the publications (1987-2017)

Scopus		Web of Science	
Language	**%**	**Language**	**%**
English	71%	English	76%
Portuguese	17%	Portuguese	12%
Spanish	12%	Spanish	12%
	100%		100%

Thus, in the face of all this data gathered through the bibliometric method applied in the Scopus and Web of Science databases, it is possible to conclude how studies on innovation are being developed by Latin American authors living in the region. Given, the following concluding section presents the conclusions drawn from the data gathered in this paper, as well as the limitations that can serve as suggestions for future studies.

Conclusions

By reaching the article's objective of analyzing a quantitative panorama (bibliometric analysis) about the studies that comprise the innovation theme in the Latin American context, it was possible to perceive that Latin America is a vital region for the development of this theme. Latin America is responsible for 8% of the world GDP, comprised 8.5% of the world population and maintained an average growth rate of 4.9% during the period between 2002 and 2012, which is above the world average (International Monetary Fund, 2013). Furthermore, the world economic context shows that from the 1990 decade to 2014, Latin America characterized as a region with positive economic performance, macroeconomic stability, and growing visibility in the media (Brenes et al., 2016). Despite the favorable scenario during the period, the region only marginally contributes to the innovation activities worldwide (Ketelhon & Ogliastri, 2013). Therefore, obtaining information regarding the panorama of the different research areas is a necessary task.

This study aimed to provide an overview of the innovation studies performed by Latin American authors. Thus, this analysis provides a guide for newcomers on the innovation field by presenting information on the journals to refer to and the most prominent authors in the Latin American context. The results indicate that despite the region's economic and populational representativeness, until 2006, there were few innovation studies. The number of publications only grew after 2006, placing Brazil, Mexico, Colombia, and Chile as the region exponents. Although this growth was representative for the region, it represented very little when compared to the world's publication, that is, the Latin American region produces, on average, 2.75% (in both databases) of the world's publications on innovation. According to Crespi and Dutrénit (2014), this can be justified by the low GDP ratios invested in R&D. Sanz and Jones (2013) highlight that Latin-American companies invest 0.5% of their gross revenue on research and development, in comparison to more developed regions which invest 2%. In this scenario, Mexico invests 0.47% of the GDP in R&D, Argentina invests 0.40%, Uruguay 0.19%, while the United States, one of the countries with the highest number of publications, according to data from De Negri and Squeff (2014), invests 2.8% of its GDP on R&D. Besides, another fact that corroborates for the low R&D investment rates is the number of patents derived from these investments, and this is clear in the comparison between the leading regions in the number of patents and Latin America. While Asia, North America, and Europe account for 49.7%, 26.1%, and 18.6% of the world patent applications, Latin America only accounts for 3.0% of the applications.

Regarding the comparison of Latin American countries with the world leading publishing countries, the United States ranks first, followed by the United Kingdom and China. Nonetheless, the only Latin American country to figure among the top fifteen publishing countries is Brazil, which occupies the fifteenth position in the Scopus database, ahead of countries like Sweden and Denmark. Such a phenomenon is noted when we assess the difference in the number of publications of Latin American countries. The difference between Brazil and the rest of the block is significant, which gives prominence to Brazilian researchers, as well as Brazilian universities. However, despite the majority regarding publications, Brazil is still behind such countries as Chile and Trinidade and Tobago in C/P and P/Pop indices. Nevertheless, in spite of the higher C/P and P/Pop scores when compared to Brazil, the quantity of publications in absolute terms of Chile and Trinidadand Tobago are still inferior to the Brazilian numbers – together, both countries have less than half Brazilian publications – which highlights the Brazilian protagonism in the region. A reflection of that resides on Brazilian institutions ranking first in publication numbers. Another fact that can justify that, according to Crespi and Dutrénit (2014), is the investment in R&D which corresponds to 1.16% of the Brazilian GDP, higher than the rest of the Latin American countries.

Moreover, we also found that Latin American countries still fall short on publications about innovation. This scenario may be an explanatory factor as to why the region does not figure among the developed regions of the world since innovation is an explanatory variable to verify performance differences between firms, regions, and countries (Zawislak et al., 2017). Nevertheless, this scenario of relative delay presented by Latin America in comparison to the rest of the world seems to be slowly fading. This decrease in the delay is because the world, for a long time, did not present significant volumes of publications either and in a given period the volume of publications escalated (Fagerberg & Verspagen, 2009). In such logic, we observe that the trajectory of innovation studies in Latin America is following the global tendency, but with a certain delay. Thus, the Latin American region still presents a marginal contribution to the bibliographic production about innovation in the world (Ketelhöhn & Ogliastri, 2013).

Finally, the elaboration of this paper is justified on the incipient existence of bibliometric studies focused on innovation that encompass the region which, in turn, leads to the inexistence of reliable indicators to support decision-making regarding public policies for the development of the area. As mentioned on the introduction, bibliometric papers address innovation in their most diverse aspects, from innovation in general to specific areas of innovation, such as open innovation and innovation in services (Fagerberg & Verspagens, 2009; Fagerberg et al., 2012; Zhu & Guan, 2013; Sun & Grimes, 2016; Cancino, Merigó & Coronado, 2017), nevertheless, none of these papers has focused on Latin America. In the region, under the optics of the bibliometric method, a few studies though, stand out by addressing different scopes, such as the paper of Ronda-Pupo (2016), who mapped the Latin American knowledge on management, the work of De Moya-Anegón and Herrero-Solana (1999), who compared the bibliometric and scientific indicators of the region, and that of Collazo-Reyes (2014), whose research theme addressed the growth of Latin American journals.

Additionally, this article provides important subsidies for the elaboration of public policies. First, we identified that the volume of studies on innovation has grown in the last decades, which provides evidence for the existence of a critical body of researchers which can further develop research on the field. Nevertheless, not all countries in the region present a body of scholars researching the area and, based on that, we suggest countries with a reduced amount of research on the theme to increase investments on the innovation field. Second, our findings show that Latin-American researchers have collaborated with leading countries on this knowledge field. Therefore, we suggest researchers to advance this collaboration. Third, public policies must focus on increasing the quality and the impact of the research from the region. This is the case of Brazil, where the challenge resides on the impact of research rather than on the quantity. On the other hand, for the rest of the Latin-American countries, the challenge is to increase the quantity while maintaining the impact of the research conducted. Finally, we recommend a set of informative and formative public policies to develop an innovation culture in the region. The development of an innovation culture must be the sum of conjoint efforts from economic agents, practitioners, workers, and public agents. Developing such an innovation culture is a long-term task which will result in a driver to lead the economic growth in Latin America in the next decades.

Despite reaching its objectives, this paper has limitations. One limitation resides on a parcel of the Latin American authors that may not have been counted. Alternatively, these authors may be affiliated to institutions that are outside the study's coverage field.

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ISSN: 0718-2724. (http://jotmi.org)

Utilizing technology acceptance model (TAM) for driverless car technology adoption

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Abstract: This paper examines the relationship between perceived usefulness of driverless car technology, perceived ease of use of driverless car technology, years of driving experience, age and the intention to use driverless cars. This research is a cross-sectional descriptive correlational study with the Technology Acceptance Model as its theoretical framework. The primary method of data collection was an online survey. Pearson's correlation and multiple linear regression were used for data analysis. This study found significant, positive relationships between perceived usefulness of driverless car technology, perceived ease of use of driverless car technology and intention to use driverless cars. Also, there were significant, negative relationships between years of driving experience, age and intention to use driverless cars.

Keywords: driverless car technology adoption; technology acceptance model; innovation adoption; society; autonomous vehicles

Submitted: May 11th, 2018 / Approved: November 27th, 2018

Introduction

The global automotive industry is now at a turning point for the transportation phase change due to driverless car technology (DCT), which potentially has groundbreaking economic, regulatory, and social implications (Bansal, Kockelman, & Singh, 2016; Gadepally, 2013; Howard & Dai, 2014; Knight, 2013; Maarafi, 2015). DCT represents a disruptive change that could potentially revive the concept of single occupancy cars and initiate a socio-cultural revolution (Brett, 2016). A driverless car (DC) is an unmanned vehicle that is capable of maneuvering without human input but utilizes the support of several sophisticated sub-systems and devices (Owczarzak & Żak, 2015).

DCT has its roots as far back as 1926 when Achen motors, an automotive distributor, demonstrated a 'phantom car tour' around the city of Milwaukee (Menon, 2015). However, it was not until 2005 when Stanley, the winning robot of Defense Advanced Research Projects Agency (DARPA) Urban Challenge, completed the 150-mile obstacle course and provided more realistic technological solutions regarding the feasibility of DCT (Guerra, 2016; Thrun et al., 2006).

The consumers of the automobile industry have experienced many incremental automation changes to the cars driven today (Jiang, Petrovic, Ayyer, Tolani, & Husain, 2015). Collision avoidance system, park assist, adaptive cruise control, and lane change assist are some examples of the driver assistance systems that are currently available commercially (Howard & Dai, 2014; Zindler & Geiss, 2016). These systems provide car manufacturers with building blocks that ultimately furnish the role of feeding into DCT (Howard & Dai, 2014).

Research has validated that social change is a consequence of technological change (Mohd, Ahmad, Samsudin, & Sudin, 2011). Automation cannot achieve its potential if its latent users do not adopt and if it is associated with improper reliance during early stages of implementation (Ghazizadeh, Lee, & Boyle, 2012).

For DCT to be successful shortly, gaining social acceptance and anticipating factors impacting the adoption of DCT from the perspective of users has to be researched in-depth (Bansal et al., 2016; Heide & Henning, 2006; Menon, 2015; Payre, Cestac, & Delhomme, 2014). The literature shows evidence that the technology of DC is considerably ahead of the research examining the social acceptance of this technology (Guerra, 2016). Moreover, existing studies within this domain seem to differ in the results of DCT acceptance with varying demographics and geography. The leadership of automobile organizations could benefit from the new data, regarding the factors influencing acceptance of DCT, which will facilitate their decision-making and guide resources towards an appropriate direction.

The societal benefits of DCT, such as providing mobility solutions for all consumers regardless of their age, skills, and ability (Brett, 2016), warrant in-depth research into the social acceptance of this technology. Understanding the factors that influence the consumer adoption structure of DCT will guide the future research of more dependable and socially acceptable vehicles (Matthews, 2016).

The purpose of this study was to determine whether there is a relationship between the perceived usefulness of driverless car technology, perceived ease of use of driverless car technology, years of driving experience, age (independent constructs) and the intention to use driverless cars (dependent construct).

The perceived usefulness of DCT was the extent to which potential consumers of DC perceive this technology enhances their mobility, which eventually may influence their intentions to use DC. The perceived ease of use of DCT was the extent to which potential consumers of DC perceive the degree of ease associated with this technology, which eventually may influence their intentions to use DC. The intention to use DC construct represented the behavioral intention of potential consumers to adopt DC.

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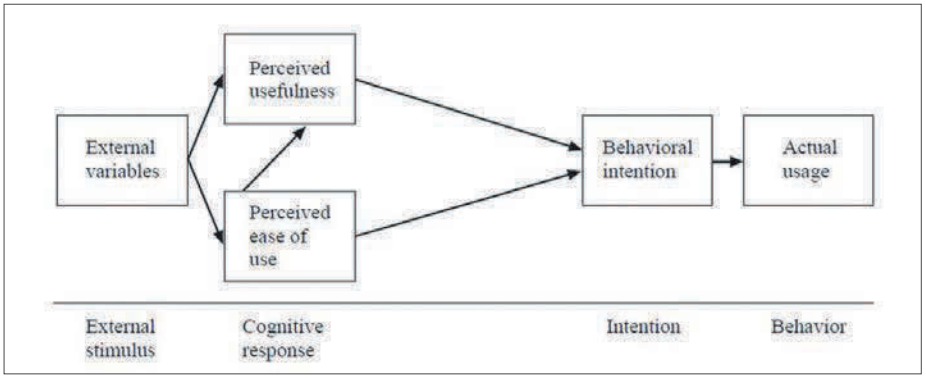
ISSN: 0718-2724. (http://jotmi.org)

Technology Acceptance Model

The Technology Acceptance Model (TAM; Davis, 1989) will continue to remain the hotspot of research as new technologies are evolving (Horton, Buck, Waterson, & Clegg, 2001; Venkatesh, Davis, & Morris, 2007). TAM is one of the most effective and widely used information systems theoretical frameworks (Holden & Karsh, 2010; Lee, Kozar, & Larsen, 2003; Li, 2010).

As shown in Figure 1, TAM is a proven powerful framework for determination of early user acceptance and the original scale measures the TAM constructs within the context of different technologies across populations and is sufficiently validated (Davis & Venkatesh, 1996). An early indication of user acceptance becomes critical when huge financial implications are associated, especially with new, emerging technologies (Davis, 1993).

Figure 1. TAM model. Adapted from Davis & Venkatesh, 1996, p. 20.



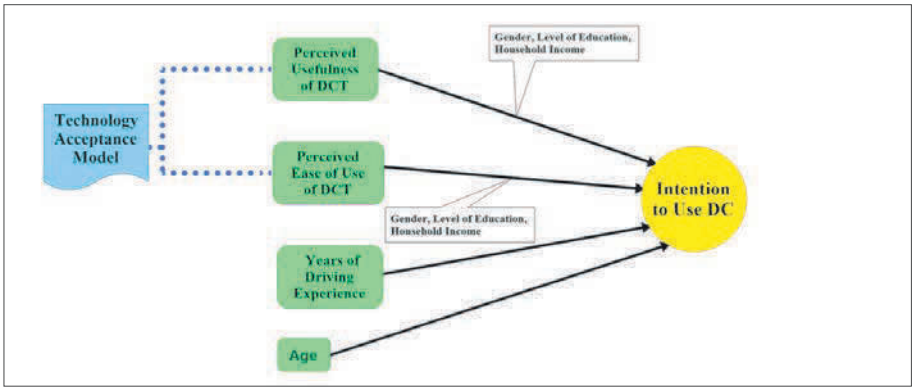
The most common usage of TAM has evolved to be the determinant of the relationship between perceived usefulness (PU), perceived ease of use (PEOU), and anticipated future usage of many emerging technologies (Horton et al., 2001). The reliability of the items of the TAM constructs measured via Cronbach's alpha has been found to exceed 0.9 across numerous studies (Davis & Venkatesh, 1996; Yousafzai, Foxall, & Pallister, 2007a). TAM has found its application in various settings, such as, but not limited to, online learning, social networking media, intranet, and smartphones. For example, a study of factors influencing attitudes towards adoption of mobile commerce provided empirical evidence that the TAM model can be applied to the field of mobile commerce and provided sufficient explanation of consumer adoption intentions (Yang, 2005). Similarly, another study on the acceptance of advanced mobile services validated the application of TAM (López-Nicolás, Molina-Castillo, & Bouwman, 2008). Further, Jansson, Marell, and Nordlund (2010) explored the factors regarding consumers' adoption associated with alternate fuel eco-friendly car technology.

Research Model

The research model of this study is shown in Figure 2. The current literature on DCT adoption constitutes of descriptive univariate analysis. This work attempted to apply the theoretical constructs available from TAM to the domain of DCT adoption. The study conducted by Schoettle and Sivak (2014) provides valuable information about the general perceptions of potential consumers of DCT. However, this paper aims to build more specificity by examining relational aspects between technology acceptance constructs and the intention to use DC.

Similarly, Menon (2015) pointed out that the factors influencing adoption of DCT can potentially change over time and as technology evolves. This study attempts along a similar path to ascertain consumers' perceptions in a different setting and, thus, to present new data. Further, investigating the acceptance of driverless car technology by Nees (2016) concluded that acceptance of DCT was low in older people and people with more driving experience. This study attempted to confirm these results in a different setting.

Figure 2. Research Model.



Methodology

The cross-sectional, descriptive, correlational research design was the underlying methodology of this study, which obtained quantitative data regarding consumers' perceptions of fully driverless transportation in the U.S. The research questions that are addressed in this study are as follows:

Q1: To what extent does a relationship exist between the perceived usefulness of driverless car technology and the intention to use driverless cars?

Q2: To what extent does a relationship exist between the perceived ease of use of driverless car technology and the intention to use driverless cars?

Q3: To what extent does a relationship exist between the number of years of driving experience and the intention to use driverless cars?
Q4: To what extent does a relationship exist between age and the intention to use driverless cars?

Q5: To what extent do the socio-economic demographic variables (Gender, Level of Education, and Household Income) moderate the relationship between the perceived usefulness of driverless car technology and the intention to use driverless cars?

Q6: To what extent do the socio-economic demographic variables (Gender, Level of Education, and Household Income) moderate the relationship between the perceived ease of use of driverless car technology and the intention to use driverless cars?

Q7: What is the combined impact of perceived usefulness of driverless car technology, perceived ease of use of driverless car technology, number of years of driving experience, and age on the intention to use driverless cars?

Instrument

The study utilized modified versions of existing instruments and items used for each construct are discussed in Table 1.

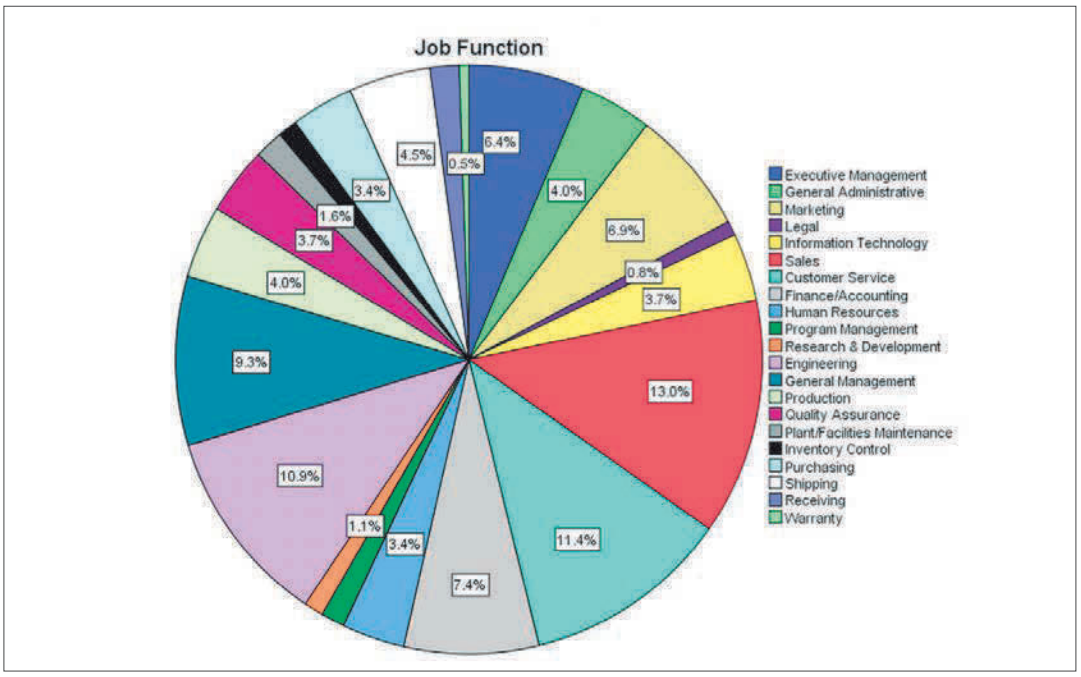
Table 1. tems Utilized in the Study Instrument.

Construct	Item
Intention to use DC	*Adapted from Nees, 2016, p.1452.* 1. Given that I would have access to a driverless car, I foresee that I would use it. 2. I intend to own a driverless car when they become available in the market. 3. I intend to add a driverless car on the list of my favorite cars.
Perceived Usefulness of DCT	*Adapted from Davis and Venkatesh, 1996, p.45.* 1. I think using a driverless car would allow me to be more productive. 2. I believe that I would find a driverless car useful for driving. 3. I feel using a driverless car would allow me to be safer while in the car. 4. I think using a driverless car would reduce traffic-related problems. 5. I sense using a driverless car would reduce driver stress and improve driving performance. 6. I foresee that a driverless car would enhance the mobility of people regardless of their age, skill, and ability.
Perceived Ease of Use of DCT	*Adapted from Davis, 1989, p.340* 1. I think learning to operate a driverless car would be easy for me. 2. I believe my interaction with a driverless car would be clear and understandable. 3. I think it would be easy for me to become skillful at using a driverless car. 4. I believe I would find a driverless car easy to use.
Additional Variables	1. Age 2. Gender 3. The current level of education 4. Ethnicity 5. Household income 6. The current state of residence 7. The current job function 8. Number of years of driving experience

Participants

The employees working at a truck accessory manufacturer were the participants of this study. The organization has 13 subsidiaries located across various states within the U.S. The proportional stratified sampling method was utilized to select the sample (n =377) as different divisions were strata with unequal size. The sample embodied a diverse occupational background as shown in Figure 3.

Figure 3. Distribution of Study Sample by Job Function.



Data Collection

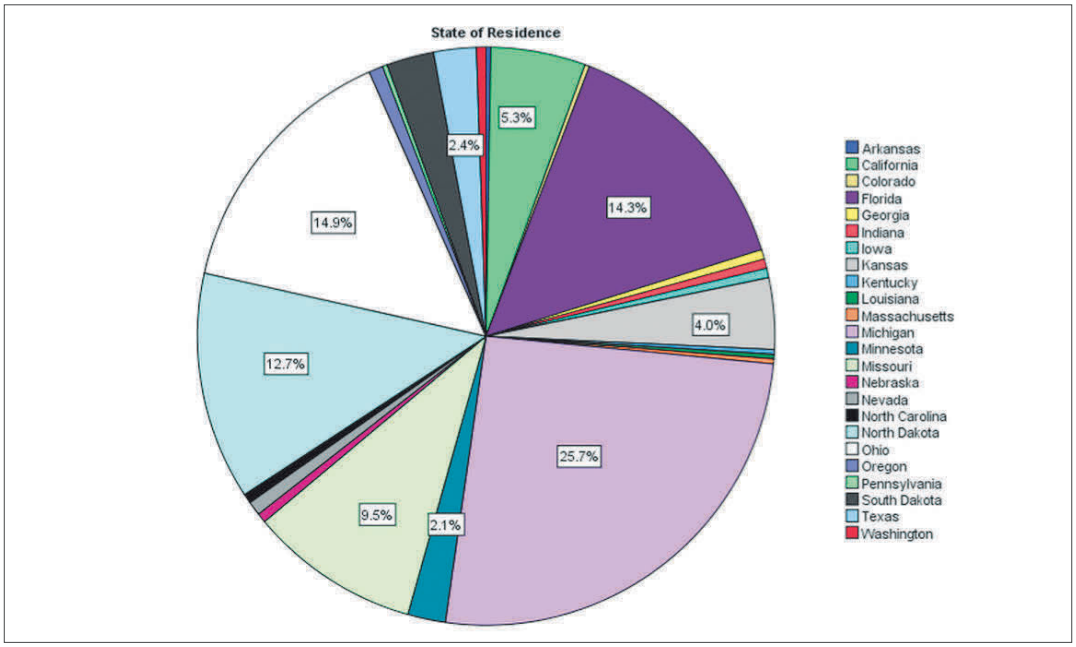
A link to Survey Monkey incorporating the study instrument was distributed via email to the sample located in all 13 subsidiaries of the selected organization across the U.S. For background information, the definition and picture of a DC along with a brief video on DCT were provided. The survey incorporated two dummy questions to assess the presence of mind of respondents. The survey remained open for ten business days.

Finally, a sample of 377 out of 567 responses was included in this study due to various reasons for exclusion, such as missing values, wrong answer on dummy questions, and outlier tests.

Validity and Reliability

The reason for the selection of 13 subsidiaries of the participant organization across the U.S. was to minimize threats to external validity, which could help in cautiously generalizing across a wider population. The distribution of the sample across various states of the U.S. is shown in Figure 4.

Figure 4. Sample by the State of Residence.



Out of the 377 responses used for this study, 20 (5.3%) reported residing in California, 54 (14.3%) in Florida, 15 (4.0%) in Kansas, 97 (25.7%) in Michigan, 36 (9.5%) in Missouri, 48 (12.7%) in North Dakota, and 56 (14.9%) in Ohio.

Each construct was measured on a Likert-type scale of five points and five anchors. Cronbach's $\alpha > 0.7$, as per academic quantitative research standards, was used to validate the scale's internal consistency. It was determined that the items used on the instrument have appropriate internal consistency as shown in Table 2.

Table 2. Reliability Analysis of the Instrument.

Scale	Cronbach's α	Number of Items
Intention to use DC	0.902	3
Perceived usefulness of DCT	0.896	6
Perceived ease of use of DCT	0.899	4

Analysis and Results

We used the inferential statistical techniques shown in Table 3 to determine the strength and direction of the relationships between the perceived usefulness of DCT, perceived ease of use of DCT, years of driving experience, age and the intention to use DC. The Statistical Package for the Social Sciences (SPSS) 24.0 was used for performing the different statistical procedures.

Table 3. Data Analysis Approach

Research Question	Inferential Statistical Technique
Q1	Pearson Correlation
Q2	Pearson Correlation
Q3	Pearson Correlation
Q4	Pearson Correlation
Q5	Pearson Correlation
Q6	Pearson Correlation
Q7	Multiple Linear Regression

A preliminary examination of the data revealed that the assumptions of linearity, independence of errors, normal distribution, and collinearity were reasonably met.

Demographic Analysis

Demographic data of the participants that include gender, age, education level, ethnicity, and annual household income are presented in Table 4. Even though the number of male participants was more than double the number of female participants, due to the large sample size, we had sufficient female participants to test the moderation effects of this variable. Due to the nature of the data, the moderation effects of ethnicity variable were not included in this study.

Table 4. Participants' Demographics

Variables		Frequency	Percentage
Gender	Male	258	68.44%
	Female	119	31.56%
Age (years)	18-20	07	1.86%
	21-24	26	6.90%
	25-30	67	17.77%
	31-34	38	10.08%
	35-40	59	15.65%
	41-50	98	25.98%
	51-60	60	15.92%
	60+	22	5.84%
Education	High School	43	11.41%
	Technical Training	17	4.51%
	Some College - No Degree	103	27.32%
	Associate Degree	37	9.81%
	Bachelor Degree	144	38.20%
	Graduate Degree	33	8.75%
Ethnicity	American Indian/ Alaskan Native	4	1.06%
	Asian/Pacific Islander	6	1.59%
	African American	12	3.18%
	Hispanic	27	7.16%
	Caucasian	328	87.01%
Annual Household Income	$0 - $24,999	12	3.18%
	$25,000 - $49,999	64	16.97%
	$50,000 - $74,999	72	19.10%
	$75,000 - $99,999	82	21.75%
	$100,000 - $124,999	65	17.24%
	$125,000 - $149,999	28	7.43%
	$150,000 - $174,999	17	4.51%
	$175,000 - $199,999	11	2.92%
	$200,000+	26	6.90%

The Result of Research Questions

Table 5 shows Pearson correlations between Perceived Usefulness of DCT, Perceived Ease of Use of DCT, Years of Driving Experience, Age and the Intention to use DC. The significance threshold for this study was set at $p \leq 0.05$.

Table 5. Pearson Correlations among various constructs.

	Intention to Use DC
Perceived Usefulness of DCT	0.780***
Perceived Ease of Use of DCT	0.387***
Years of Driving Experience	-0.144**
Age	-0.123*

Note. † = $p < 0.10$, *= $p < 0.05$, **= $p < 0.01$, ***= $p < 0.001$, and $n = 377$ for all analyses.

The results of the research questions analyses are shown in Table 6. The SPSS output reflecting an overall multiple linear regression model summary and beta coefficients examining the impact on the dependent construct is shown in Table 7 and Table 8, respectively. The beta values shown in Table 8 (B - Perceived Usefulness of DCT = 0.420; B - Perceived Ease of Use of DCT = 0.127; B - Years of Driving Experience = -0.390) represents the average change in a consumer's intentions to use DC for each increment change in the perceived usefulness of DCT, perceived ease of use of DCT, and years of driving experience, respectively. The beta value for age is not statistically significant and therefore, is not a predictor of consumer's intentions to use DC.

Table 6: The Results of Research Questions

Research Question	Statistical Analysis Result
Q1: To what extent does a relationship exist between the perceived usefulness of DCT and the intention to use DC?	The perceived usefulness of DCT and the intention to use DC have a strong, statistically significant positive relationship ($r = 0.780$, $n = 377$, $p < 0.001$).
Q2: To what extent does a relationship exist between the perceived ease of use of DCT and the intention to use DC?	The perceived ease of use of DCT and the intention to use DC have a moderate, statistically significant positive relationship ($r = 0.387$, $n = 377$, $p < 0.001$).
Q3: To what extent does a relationship exist between the number of years of driving experience and the intention to use DC?	Years of driving experience and the intention to use DC have a weak, statistically significant negative relationship ($r = -0.144$, $n = 377$, $p < 0.01$).
Q4: To what extent does a relationship exist between age and the intention to use DC?	Age and the intention to use DC have a weak, statistically significant negative relationship ($r = -0.123$, $n = 377$, $p < 0.05$).
Q5: To what extent do the socio-economic demographic variables (Gender, Level of Education, and Household Income) moderate the relationship between the perceived usefulness of DCT and the intention to use DC?	Gender, level of education, and household income were not found to have any moderating influence on the relationship between the perceived usefulness of DCT and the intention to use DC. *Gender as a moderator*: Male ($r = 0.774$, $n = 258$, $p < 0.001$) Female ($r = 0.802$, $n = 119$, $p < 0.001$). *Level of education as a moderator*: Low Education ($r = 0.817$, $n = 200$, $p < 0.001$) High Education ($r = 0.747$, $n = 177$, $p < 0.001$). *Household income as a moderator*: Low household income ($r = 0.822$, $n = 148$, $p < 0.001$) Medium household income ($r = 0.729$, $n = 147$, $p < 0.001$) High household income ($r = 0.811$, $n = 82$, $p < 0.001$).
Q6: To what extent do the socio-economic demographic variables (Gender, Level of Education, and Household Income) moderate the relationship between the perceived ease of use of DCT and the intention to use DC?	Gender, level of education, and household income were not found to have any moderating influence on the relationship between the perceived ease of use of DCT and the intention to use DC. *Gender as a moderator*: Male ($r = 0.377$, $n = 258$, $p < 0.001$) Female ($r = 0.407$, $n = 119$, $p < 0.001$). *Level of education as a moderator*: Low Education ($r = 0.406$, $n = 200$, $p < 0.001$) High Education ($r = 0.364$, $n = 177$, $p < 0.001$). *Household income as a moderator*: Low household income ($r = 0.340$, $n = 148$, $p < 0.001$) Medium household income ($r = 0.446$, $n = 147$, $p < 0.001$) High household income ($r = 0.353$, $n = 82$, $p < 0.01$).
Q7: What is the combined impact of perceived usefulness of DCT, perceived ease of use of DCT, number of years of driving experience, and age on the intention to use DC?	The multiple linear regression model sufficiently explains the dependent construct of intention to use DC ($R^2 = 0.622$, $n = 377$, $p < 0.001$). By evaluating R^2, a statistical interpretation can be made that 62.2% of the variance in the intention to use DC is explained by the combination of the perceived usefulness of DCT, perceived ease of use of DCT, and years of driving experience.

Table 7. Multiple Regression Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.791	0.626	**0.622**	2.329	0.626	155.781	4	372	**0.000**	1.942

Table 8. Beta Coefficients.

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	Variance Inflated Factor
1	(Constant)	-1.943	0.742		-2.617	0.009	-3.403	-0.483		
	Perceived Usefulness of DCT	**0.420**	0.020	0.732	21.385	**0.000**	0.382	0.459	0.818	1.166
	Perceived Ease of Use of DCT	**0.127**	0.037	0.117	3.436	**0.001**	0.054	0.200	0.861	1.162
	Years of Driving Experience	**-0.390**	0.186	-0.193	-2.097	**0.037**	-0.756	-0.024	0.119	8.409
	Age	0.317	0.196	0.149	1.616	0.107	-0.069	0.702	0.119	8.418

Comparative Analyses

The existing research findings have indicated that the TAM constructs of Perceived Usefulness and Perceived Ease of Use are significant factors for anticipating future usage of different technologies across various settings (Davis & Venkatesh, 1996; Dillon & Morris, 1996; Drennan, Kennedy, and Pisarski, 2005; Lee et al., 2003; Park, Kim, Shon, and Shim, 2013). These findings are consistent with the findings of this study that revealed as the perception of usefulness associated with DCT increased, the intentions of potential consumers to use DC strongly increased. Also, as the perception of ease of use associated with DCT increased, the intentions of the potential consumers to use DC moderately increased.

Thus, due to the strongest correlation in this study, it is proposed that the perceived usefulness construct be served as a noteworthy focus area for the marketers of DCT. Also, it is speculated that once usefulness of DC technology is established, consumers may put forth the effort required to learn this technology. However, Lane and Coleman (2012) found that higher Perceived Ease of Use led to higher Perceived Usefulness, which ultimately led to higher usage of technology.

This work found that as consumers' years of driving experience increased, the intentions of potential consumers to use DC decreased slightly. Also, the data revealed that with an increase in consumers' age, the intentions of potential consumers to use DC decreased slightly. These findings are consistent with existing research that the acceptance of DCT is lower in consumers with more driving experience and with older consumers (Nees, 2016).

Conclusion and Future Studies

The regression model had sufficient explanatory power with each construct, except age, is a significant predictor of consumers' behavioral intention to use DC. The Perceived Usefulness construct was shown to be the strongest predictor of intention to use DC. The constructs of the TAM framework provided a robust theoretical base for predicting DC adoption.

In the coming years, seniors are projected to constitute the majority of the U.S. population and, hence, are one of the biggest consumer bases for automobile manufacturers in the future. Therefore, it becomes of paramount significance for DCT manufacturers to develop and implement interventions in advance that will help reduce the impact of age on the intention to use DC.

This study was limited to determining only the relationships between the constructs under examination and could not predict causation. Also, Arts, Frambach and Bijmolt (2011) cautioned that, with multifaceted technological innovations, the measured adoption behavioral intention might reflect higher levels than actual adoption.

Future studies of DCT adoption may include the construct of self-efficacy as a mediating variable between the relationship of Perceived Ease of Use of DCT and intention to use DC. The level of a person's self-efficacy may mediate the relationship between Perceived Ease of Use and behavioral intentions. Even though customer resistance to innovation was not included in this study, this construct may be significant for future studies on DCT adoption research. Also, future studies can examine the impact of a user's level of experience with

currently available automotive technology, such as those specified in National Highway Traffic Safety Administration (NHTSA) level three category (e.g., lane assist, brake assist), on the intention to use DC. Moreover, a user's level of experience with currently available automotive technology may mediate the relationship between the Perceived Ease of Use of DCT and the intention to use DC. Finally, the degree to which consumers are willing to give up their driving control could be a significant factor to be considered in future studies.

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Biography

Sahil Koul received his Ph.D. in Technology from Eastern Michigan University, USA and M.S degree in Automotive Engineering from Lawrence Technological University, USA. His research interests are in interdisciplinary areas of automotive technologies including driverless car technology, technology acceptance and diffusion of emerging technologies, and examining socio-technological interactions. He has over ten years of experience in working within the automotive domain and at present, works as an engineering manager for a large North American automotive accessory manufacturer.

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Defining functional roles for research institutions in helix innovation networks

Florian Schütz[1], Fabian Schroth[1], Antonia Muschner[1], Martina Schraudner[1]*

Abstract: This paper presents an empirically grounded case-based analysis of quadruple helix innovation networks. On the basis of qualitative interviews with representatives of 16 heterogeneous networks, we investigate the functional network roles of 172 actors from the fields of academic research, business, government and society. In this article we focus on universities and research and technology organisations, which face the challenge of having to redefine their functional roles and unique value in the face of increased diversification of knowledge sources within current quadruple helix innovation systems. We delineate both existing and potential future roles for academic actors using a typology of functional roles, and present the challenges research establishments must meet in order to fulfil these roles successfully. Finally, we outline the implications of this analysis for the strategic positioning of research institutions, so as to ensure the future inclusion of their innovative capacity in collaborative innovation networks.

Keywords: quadruple helix innovation; networks; innovation networks; functional roles; roles in networks; qualitative study; microstudy; network analysis; universities; research and technology organisations

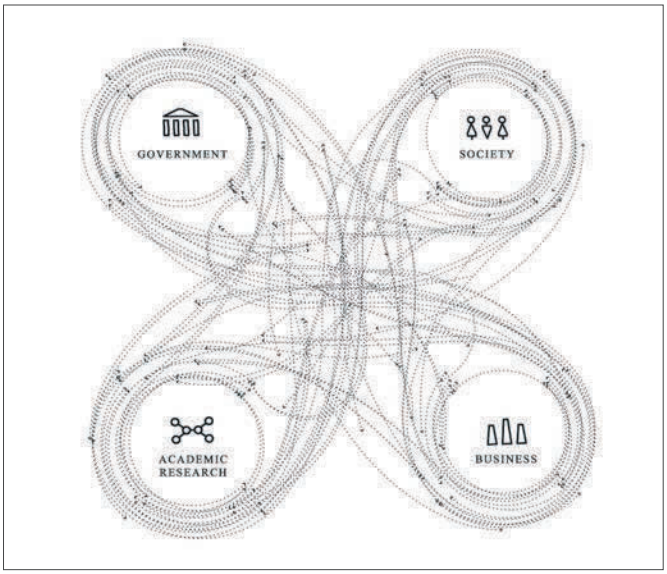
Submitted: July 18th, 2018 / Approved: November 14th, 2018

1 Introduction

Scholars increasingly conceptualise innovation systems as a multiple helix (Carayannis and Campbell, 2009; Etzkowitz and Leydesdorff, 2000). This kind of model reflects the increasing complexity of knowledge creation and diffusion. It assumes that multi-actor innovation systems rely on the dynamic and flexible interaction of diverse elements, rather than on a number of synchronised, stable processes.

The quadruple helix (QH) model in particular focusses on the interaction of four major subsystems in knowledge-driven innovation systems, namely academic research, business, government, and society. This model acknowledges that successful research and innovation depend not only on intra-organisational activities, but also on collaboration among businesses, research establishments, government actors and the public.

Figure 1 *Quadruple Helix Innovation Systems. Visualisation © Fraunhofer CeRRI*



On a micro level, this collaboration takes place in networks composed of actors from the aforementioned different subsystems. Official acknowledgement of the advantages and requirements of multi-actor collaborative innovation is reflected in the increased support for multi-actor projects on the part of both national and international research funding bodies and policymakers. In view of these developments, research establishments specialising in either basic or applied research need to bring their strategies and goals in line with transdisciplinary and collaborative forms of innovation.

Furthermore, following Gibbons et al. (1994), knowledge is no longer produced solely within academic institutions, but also by heterogeneous groups of actors in a variety of contexts, through so-called mode 2 knowledge production. The unique role of the academic sector is therefore becoming increasingly indeterminate. For research establishments used to working in linear push-pull models, responding to this changing context presents a nontrivial challenge.

This is further exacerbated by the fact that it is currently unclear how and to what extent the innovative potential of various actors – in particular research institutions, small and medium-sized enterprises (SMEs) and societal actors – can be meaningfully integrated into multiple helix innovation networks. It is likewise not clear how costs, risks, benefits and opportunities can or should be distributed between the actors in accordance with their respective roles.

Answering these questions requires a clearer understanding of the qualitative and functional aspects of existing roles in QH innovation networks. This would in turn shed light on the challenges faced by traditional academic actors, which in Germany can be divided into two subcategories. Firstly, there are four major public research institutions with missions ranging from the furtherance of basic research to the advancement of applied research for the development of products and processes. The second category consists of higher education institutions such as universities, which in addition to conducting research are also providers of education.

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ISSN: 0718-2724. (http://jotmi.org)

As the functional roles of academic actors within QH networks are particularly under-investigated, they form the focus of our study, in which we ask the following question: Which functional roles exist in QH innovation networks for actors in the academic sector?

In the following sections we present a literature review, our methodological approach and our empirical findings.

2 Literature review and theoretical framework

The existing literature on QH innovation networks focusses primarily on the macro level, i.e. on national or regional innovation systems (Carayannis and Campbell, 2012). Innovation processes in these networks are described as dynamic and flexible, and marked by the interaction of a multitude of actors representing business, government, academic research and civil society – leading to innovations that are particularly capable of addressing and solving societal problems.

A central aspect of the QH model of competitive innovation is so-called mode 3 knowledge, which is based on the ability to combine various bodies knowledge and perspectives on innovation in a manner that integrates the existing expertise and knowledge production dynamics of all actors involved. It entails the continued co-existence of other modes of knowledge production, which continue to evolve through mutual influence – for instance when traditional academic research (mode 1) is used in conjunction with transdisciplinary research (mode 2). Mode 3 contains inter- and transdisciplinary forms of knowledge production, during which existing bodies of knowledge and modes of knowledge production are maintained and harnessed for innovation. It is only through this preservation of plurality that the mutual enrichment of different bodies of knowledge becomes possible. Three processes are critical in this respect, namely "co-evolution", or joint development and mutual adaptation, "co-specialisation", i.e. joint and coordinated specialisation, and "co-opetition", which is a productive duality of competition and cooperation (Carayannis and Campbell, 2006; 2009; Carayannis *et al.*, 2012). The successful integration of the various modes and bodies of knowledge is seen as fundamental to the development of sustainable national innovation ecosystems (ibid.).

The QH model increasingly informs official research and innovation policy, as well as the development of national and regional innovation systems (McAdam and Debackere, 2018). At the same time, little has been written about the challenges and possibilities QH innovation networks hold for traditional actors such as research establishments – which is surprising, especially in light of the aforementioned new mode of knowledge production lying at the basis of these networks. For traditional academic actors, the changing demands of knowledge production, coupled with increased integration of societal actors in innovation processes, can be expected to result not only in new challenges and opportunities, but in fact new roles within the innovation process.

One approach to understanding these challenges and the complexity of QH networks is case-based microanalysis. The insights gained through this type of enquiry are crucial to the future practical design of such networks (Miller *et al.*, 2018). Early case-based microanalyses of QH networks investigate their evolution from triple helix networks, focussing in particular on the roles actors from different sectors play in their creation. Thus Arnkil et al. examine how in creating and furthering QH networks, government actors occupy the role(s) of "enabler", "decision maker", "supporter", "utiliser", "developer", "marketer" and/or "quality controller" – depending on the structure of the network in question (Arnkil *et al.*, 2010). A central question in these studies is how the fourth helix, namely society, can be integrated into existing triple helix innovation networks. Accordingly, Lindberg et al. (2014) examine how NGOs can incorporate civil concerns into existing networks, and look at the challenges they face in doing so. Cunnhigham et al. (2017) show how individual academic researchers can achieve a similar result by means of boundary spanning. Nordberg (2015) in turn focusses on a single research institution to show how it can use its position at the intersection of academic research and government to open up existing triple helix networks to social actors.

All of the above entails changes and shifts in the roles played by classical innovation actors. Academic institutions are no longer the sole providers of research and education; local government, for example, can also fulfil this function. No longer exclusive providers of cutting-edge knowledge, research establishments instead increasingly corroborate knowledge developed by other actors (MacGregor, 2010).

In short, the existing literature shows that knowledge production, innovation systems and the roles of innovation actors are all changing. On the one hand, it is argued that research establishments are no longer the exclusive producers of knowledge in QH networks. On the other hand, academic actors are increasingly seen to perform the function of interfacing the other three sectors for the sake of integration into innovation networks. This paper expands upon this exploration of roles in QH innovation networks by means of the empirical investigation presented below.

3 Methodology

The aim of our micro study was to gain a thorough understanding of how cooperation among different actors in QH innovation networks is structured, via a differentiated analysis of the functions and roles of the actors in selected QH networks. As the goal was the discovery and thorough understanding of new types of functional roles, we chose to conduct our research in the form of a qualitative case study adhering to the principle of openness (Flick *et al.*, 2010; Lamnek, 2010).

A qualitative sampling scheme (Merkens, 2010) was used to identify 16 different networks as cases for the study; the relevant criteria being the number of actors from each of the four subsystems, and the degree of innovativeness of the project in question. We aimed to achieve a diverse distribution of actors from different subsystems in our sample, in order to recreate the quadruple helix on a micro level. We furthermore looked for networks initiated by actors of different subsystems so as to allow for a wider variety of possible role types within

the sample, continuing until theoretical saturation was reached. The respective projects of the selected networks cover a wide range – from social innovations such as sustainable mobility solutions, to the development of new technological devices.

Each of the participating networks was asked to nominate one to three representatives, with whom semi-structured and problem-centred interviews of about 90 minutes each were conducted. As a means of systematically gathering information about the various relationships within the networks, each interviewee was asked to create a so-called network map (Straus, 2010; Wolf, 2006). The aim was to have interviewees create visual representations of their respective networks, to serve as a powerful speaking prompt and offer a basis for methodical discussion of the network in question. The first step was to elicit the names of network participants that play an important part in the innovation process, by means of a name generator: respondents were given stickers on which to write the names of the relevant organisations, and were asked to be as precise as possible in each case. They then placed these stickers on a network map template prepared by the research team, thereby revealing the position of the various actors within the network from their perspective. The interviewees themselves could determine the number of alters, and there was no prescribed time frame (e.g. by limiting alters to actors with whom they had dealings within the last three months). The practical advantage of this methodological approach is that the network ego – not the interviewee as individual, but rather the organisation – determines the borders of the network. Once the alters had been named, respondents were given stickers with follow-up questions that functioned as name interpreters. These questions dealt with roles, opportunities, risks and tasks; the aim being to arrive at a detailed description of each named alter in terms of each of these characteristics.

In conjunction with the network maps drawn up by the interviewees, a pre-prepared interview guide was used to structure the interviews around questions regarding the actors within the network, and the distribution of roles, opportunities and risks.The interview guide was developed on the basis of the theoretical framework and research question as presented in section 2 above.

The interview records were transcribed and the relevant information was extracted and ordered by means of qualitative content analysis (Mayring, 2010). Within the 16 networks, a total of 172 actors could be identified. The interviewees' analyses of the actors in their respective networks resulted in a total of 239 descriptions of distinct roles, which were labelled using in vivo coding. The reason this number exceeds that of the actors themselves is that single actors can occupy more than one role. Said roles were defined in terms of several dimensions, namely the actors' functions within the network, their unique value proposition, means of collaboration, and their input and output in the network. In addition, the nature of the actors in each of these roles was noted, as well as their respective positions within the quadruple helix. The next step was to reduce the abovementioned 239 role descriptions to 26 typical functional roles, following Kluge's (2000) approach to typology construction.

Accordingly, the functional roles presented below should be understood as generalised types. Although individual cases may deviate from these types in one or more respects, they remain useful in understanding and explaining the collaborative interaction of actors in QH networks.

4 Findings: Functional Roles for Research Institutions in Quadruple Helix Innovation Networks

Below we present our findings, focussing on the academic strand of the quadruple helix – i.e. on universities and research and technology organisations (RTOs). The current diversification of knowledge sources places these institutions in the challenging position of having to (re-)define their functional role within QH or mode 3 innovation networks. In the presence of other knowledge providers (such as startups and open innovation labs), academic actors need to make clear what they bring to the table – while also considering what new roles they might occupy in future innovation networks.

Research institutions as major actors

Within collaborative QH innovation networks, RTOs and universities can take up the role of "knowledge generator". In nearly all of the networks we examined, this role was played by individuals and institutions from the academic sector (with one exception, where the role was instead taken up by a business actor). "Knowledge generators" differ from other types of knowledge providers in that their primary contribution to the network consists not in pre-existing expertise, but rather the creation or development of new knowledge. Two aspects of this role stood out in the networks we analysed. Firstly, there is virtually no direct or active collaboration between these and other actors within the quadruple helix. Instead, "knowledge generators" carry out their work autonomously and then present the newly-developed knowledge to the network as a finished product. Strictly speaking, the autonomous nature of this functional role stands in contradiction to mode 3 knowledge production, which should actually form the basis of a QH network.

Secondly, it is worth noting that the main perceived benefit of "knowledge generators" is not know-how, but rather the abundant workforce academic institutions typically have at their disposal. In fact, when they become active in innovation networks, it is the "knowledge generators" themselves that primarily tend to benefit from the know-how of other actors. Participation in innovation networks moreover helps research institutions procure funding, improve their standing and expand their own professional networks, while providing the participating academic personnel with opportunities for further qualifications.

Integrating "knowledge generators" into collaborative innovation processes is seen as difficult. According to our respondents, dealing with the issue of intellectual property is a major challenge. The pace at which academic institutions tend to operate – which the respondents often juxtaposed with the work approach of the business sector – was likewise noted to be a potential hindrance to collaboration.

As providers of specialised knowledge, universities and RTOs can play the role of "knowledge supplier". This, in turn, can take two forms: "specialists" have the necessary expertise to deal with particular issues, whereas "contextualisers" are able to use their overview of particular fields to address issues within a broader academic or scientific context. In the networks we examined, however, "specialists" from the business sector noticeably outnumbered their counterparts from the academic sector. The "contextualisers", however, were exclusively academic actors – albeit individual lecturers or senior researchers, as opposed to institutions.

Actively involving academic "knowledge suppliers" in innovation networks is seen as difficult. It is in the first place not easy to find the right people for the role within the academic sector. Secondly, the role's compensation model poses its own set of challenges. The "specialists" and "contextualisers" in the analysed cases contributed their know-how not as permanent and active network members, but rather through voluntary participation in workshops. Accordingly, these actors did not consider being a "knowledge supplier" as part of their basic professional responsibilities. Rather, it was seen as an additional personal investment of time and labour, usually without financial compensation. On the other hand, this role presents academic professionals with new opportunities for knowledge exchange, and can lend added credibility to their work.

Academic actors can furthermore assume the roles of "incorruptible" and "validator". In contrast to "knowledge supplier", these roles are predicated not on expertise, but rather on academic reputation and the accordant ability to give the network's collaborative innovation processes a scientific seal of approval. "Validators" confirm the network's adherence to scientific quality standards, whereas "incorruptibles" help the network project an independent stance to the outside world, e.g. to the target users of the product, service or technology under development. Since business and societal actors are often seen as motivated by self-interest, academic institutions (or their representatives) are at a distinct advantage in this role. The integration process and compensation model for both of these roles, however, entail the same difficulties as in the case of "knowledge suppliers".

A network's "negotiators" facilitate contact and cooperation with a range of different corporate and legal entities within the innovation system. Universities and RTOs that take on this role do so mainly through procuring public funding for the network.

Strong competition for research institutions

"Interaction enablers" effectively form the hub of the network, establishing links between the various network actors and ensuring that the methods and processes needed for effective transdisciplinary collaboration are in place. They play a central role in intra-network communication, liaising or mediating between the various heterogeneous stakeholders – including in the case of different or conflicting interests, e.g. with respect to intellectual property. In the examined cases, this role was taken up by a variety of actors from each of the four sectors of the quadruple helix: large-scale enterprises, SMEs, startups, business funding agencies, hubs and incubators, government institutions, civil organisations and stakeholders, and – last but not least – RTOs and universities. Despite its aforementioned complexity, the function of "interaction enabler" is seen as primarily labour-intensive, rather than dependent on particular specialist knowledge. This explains why nearly all actors within the quadruple helix are able to assume this role.

It is difficult to define the role's compensation model on the basis of the observed cases. In many instances, its financial viability was solely tied to public funding, and not based on jointly generated revenue flowing back into the network. Still, as in the case of "knowledge generators" and "knowledge suppliers" above, actors from the academic sector stand to benefit from the role of "interaction enabler" via an increase in know-how from other network members, the opportunity to forge contacts within the field of innovation, an improved academic reputation, and added credibility.

"Network strategists" carry out a similar function, in that they provide structure to intra-network collaboration. In contrast to "interaction enablers", however, they do so not by directly enabling or overseeing collaborative processes, but rather by determining the network's overall strategy and ensuring that it is followed by all participating parties. They focus on the big picture and have little involvement in the network's day-to-day operations. Though this role was seldom present in the examined cases, "network strategists", like "interaction enablers", could be found in all four sectors of the quadruple helix.

"Pioneers" perform a function that was long the sole preserve of academic or scientific research, namely conducting cutting-edge innovation that makes use of the very latest available methods and technologies. Given that basic research and exploratory research (within the field of applied research) are among the basic tenets of the academic sector, academic actors should be well-equipped for this role. Nevertheless, in the networks we examined, all of the "pioneers" bar one (a university professor) belonged to the business sector, with the majority of the "pioneering" work carried out by established corporations and startups. This is in keeping with a current general trend, whereby corporate-startups partnerships constitute a significant source of innovative products and services.

In contrast to the practice of bilateral mergers and acquisitions in the business sector, there is as of yet no well-developed formula for integrating "pioneers" into QH networks. The issue of intellectual property often stands in the way of such collaboration, and for the corporations and startups standing at the forefront of innovation, opportunities for exchange and professional network development do not suffice as incentives for collaboration.

A similar picture arises with respect to the "thought leaders" that are responsible for most of the actual innovation within the network. In contrast to "pioneers", "thought leaders" are not defined by their cutting-edge knowledge or breakthrough ideas, but rather by their innovative mindset. As in the case of "pioneers", universities and RTOs are no longer the primary "gatekeepers" to the coveted "thought leaders". In the analysed networks, this role was mainly occupied by actors from the business sector (hubs and incubators) and from the civil

sector (NGOs). The integration of "thought leaders" or their "gatekeepers" into innovation networks presents the same challenges as in the case of "pioneers".

Potential future roles for research institutions

In our analysis, we discovered two further major functions that universities and RTOs should be capable of performing in future, despite their not assuming these roles in the networks we investigated. The network's "public face" helps the network or innovation attain greater and wider visibility. These actors can use their position in the public eye to convey innovative outcomes to particular target groups. In the examined cases, this role was mostly played by large corporations or government actors. Academic institutions could nonetheless leverage their prestigious status to the same effect.

"Business model developer" is another role that was seen as crucial by many of our respondents. "Business model developers" know how to translate the results of the network's collaborate efforts into concrete, packaged solutions that are of clear value to particular target groups and framed within a suitable business model. Many of the respondents in our study cited the lack of a business model mindset within the academic sector as a reason for preferring the business and civil sectors as sources of innovative potential. Nonetheless, this role holds significant potential for the academic sector: in taking over the function of "business model developer", academic actors could further cement their position within QH networks.

5 Conclusion and discussion

In moving beyond the largely theoretical discussion of QH innovation networks in the existing literature, the above analysis provides a better understanding of how these networks function in practice, while shedding light on certain particularly pertinent challenges. By means of a typology of functional roles, network structures and preconditions for multi-actor collaboration within a quadruple helix can be more thoroughly understood – which places actors from all four subsystems in a better position to manage their collaboration in existing QH networks.

Research establishments in particular stand to benefit from a deeper understanding of collaboration practices and roles in QH innovation networks. Currently, traditional roles played by universities and RTOs continue to inform the relationship between the academic sector on the one hand and the business sector or market on the other. Established collaboration models, for example contract research on behalf of companies, still adhere to a push-pull conception of innovation. It is, however, becoming increasingly important for research institutions to redefine their functional role within in the innovation system and to delineate the unique value they bring to the table. Only in so doing can they develop future-proof strategies in response to the growing prominence of knowledge sources outside of the academic sector.

Our study shows that universities and RTOs already occupy a variety of roles within QH networks. In some of these roles, academic institutions dominate, whereas in other instances they face strong competition from the other sectors and find it difficult to clarify their unique value proposition with respect to the network.

When it comes to the development of new knowledge, our study reveals research institutions to be in a strong position as "knowledge generators". Nonetheless, knowledge generation should in future become a more collaborative process; one that is more closely integrated with the rest of the network. If research establishments are to engage in true mode 3 knowledge production, they cannot merely contribute their own academic knowledge to the network, but have to facilitate the collaborative development of new knowledge. In other words, they additionally need to assume the role of "interaction enabler" – wherein they face competition from actors from the other three sectors of the quadruple helix. In order to cement their unique value as future "interaction enablers", research institutions should work on redefining the role, so that it is not seen as merely or primarily labour-intensive. Rather, the focus should shift to the extensive specialised knowledge needed in implementing effective transdisciplinary work processes and methods, and facilitating communication between actors from different fields. Said specialised knowledge could be developed and established within the academic sector. Thus – and by furthermore assuming the roles of "incorruptibles" and "validators" – universities and RTOs can use the diversification of knowledge sources to their advantage. Far from merely staving off redundancy, they can in fact significantly strengthen their position as indispensable actors within the innovation process.

As "knowledge suppliers" – or more precisely as "specialists" – academic actors face strong competition from the business sector. Furthermore, the conventional role of research institutions is called into question by the fact that virtually all of the "pioneers" in the observed networks are corporations and startups. If the academic sector is to gain ground in collaborative innovation, its basic mindset needs to shift and new modes of knowledge and technology transfer must be created. Only then will "thought leaders" from research institutions be able to take centre stage in QH networks. In addition, research institutions need to address the shortcomings that have been ascribed to them in their role as "knowledge suppliers" – namely the difficulty in gaining access to the right "specialists", the slow pace of academic research, and the as of yet unresolved issue of intellectual property in open innovation ecosystems.

Innovation networks increasingly turn to the business sector for expertise, especially in the field of technology, since technology experts with a business background bring the combination of a sound understanding of the latest technology and a business model mindset to the table. Research institutions could in future likewise present their knowledge as packaged solutions, framed by workable business models. This can be achieved through interdisciplinary collaboration (in particular by drawing more strongly on the social sciences) and by rethinking the distribution of tasks within knowledge and technology transfer.

Finally, research institutions and funding bodies face the task of defining new compensation models for the inclusion of academic actors in QH networks. In the analysed networks, academic professionals were

often invited to share their expertise on a one-off basis, e.g. through participation in workshops. For this they received no financial remuneration; instead, they were rewarded for their time and effort with the opportunity to forge new professional contacts. Beyond that, however, there is still the need for a sustainable compensation model – not only with respect to research institutions, but also for societal stakeholders and startups. Ultimately, all participating actors should be rewarded for the value they contribute to the network, through a proportionate share in the results of the collaborative innovation process. It must, however, be kept in mind that the academic sector operates in accordance with a different value system than business or civil society. As long as career success and pro rata compensation in the academic sector are measured in the number of publications under one's name and the amount of funding one has procured, these likewise remain the most important determiners of fitting compensation for academic actors involved in innovation networks.

In short, research institutions face the major task of strategising for the leap from bilateral push-pull cooperation to quadruple helix collaboration. An understanding of the major functional roles within QH innovation networks opens up the possibility for actors from the academic sector to take up or more effectively perform those roles. This in turn affords these organisations the chance to tap into immense potential – not only to their own benefit, but so as to improve the overall quality of collaborative innovation.

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Digital planning of the city of Barcelona and its relations with the strategic digital city

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Abstract: The demand for new ways of managing cities requires faster, more technological and more digital means of interaction and communication. In this context, the strategic digital city applies the resources of information technology in municipal management, based on its strategies. The objective is to analyze the digital planning of the city of Barcelona and its relations with the strategic digital city. The methodology of the selected research is a unique case study in Barcelona, through the research protocol. The results obtained through the analyzes have shown that the digital planning of the city of Barcelona provides information technology and strategy resources that promote practices intrinsic to the strategic digital city, showing that the city of Barcelona applies these resources to the benefit of its inhabitants, making with which this city is increasingly democratic and digital. The analyzes demonstrate how digital planning can be aided by the strategic digital city project, confirming that the population would be increasingly benefiting from the technological and strategic resources. The conclusion reiterates that digital planning makes it possible to have an interface between the population, government and organizations in public passenger transport.

Keywords: Digital Planning; Strategic Digital City; Information Technology; Strategy

Submitted: August 30th, 2018 / Approved: November 21st, 2018

1 Introduction

The demand for new ways of managing cities requires faster, more technological and more digital means of interaction and communication. In this context, the strategic digital city applies the resources of information technology in municipal management, based on its strategies. As such, technology is one of the indispensable factors for cities to keep pace with the transformation of society and meet the expectations and needs of the population (BOUSKELA et al., 2016).

Municipal planning can contribute to identify, understand and solve local problems, so government actions require planning as a continuous and ongoing process of prevention, management and control of urban management in order to promote the improvement of public services and the well- being of the population (REZENDE and FREY, 2005).

Therefore, strategic digital cities, according to Rezende (2012), apply the resources of information technology in municipal management, contributing and assisting with strategic, tactical and operational planning decisions; as well as study and make available information, systems and services to their managers and citizens.

The digital planning of the city of Barcelona has relations with the strategic digital city, as Barcelona has a network of citizen initiatives that use the technology available to organize and try to solve some of its needs, creating a more democratic and connected environment (MOBILE WORLD CAPITAL BARCELONA, 2016).

As far as the research problem is concerned, the technology has become necessary in the daily life of the population, but one of the problems is the need for urban policies that take care of the electronically excluded groups, since they may have access to the growing number of communities virtual urban spaces that have been created with the aim of citizens living in a new virtual public sphere. It is important to verify if technology really increases the capacity for participation and cooperation (LEMOS, 2005; SILVA, 2005).

The process of acculturation of information in municipalities can be facilitated and effective if citizens are interested in participating and using information technology, as well as managers in assuming the role of info managers (REZENDE, 2005). The State, in order to fulfill its function, must seek other new ways of having a more participative and democratic management (REZENDE; FREY, 2005). The problematization addressed is a consequence of the lack of integration among all institutional elements related to technology.

However, it is important to verify whether technology really enhances the ability to participate and cooperation, with the purpose of transforming these power relations. As such, they may have access to this growing number of virtual urban communities that have been created with the aim of conviviality among citizens in a new virtual public sphere (AURIGI, 2005; CASTELLS, 2003; SILVA, 2005).

Thus, it is necessary and increasingly urgent effective popular participation in the various dimensions of public policy decisions (SOUZA, REZENDE and HARDT, 2007), since, in order to fulfill its function, the State must seek new have a more participatory and democratic management. Thus, all this problematization dealt with is a consequence of the lack of integration between all institutional elements related to technology, citizens and governments (CASTELLS, 1999; REZENDE; FREY, 2005).

The main objective of this research is to analyze the digital planning of the city of Barcelona and its relations with the strategic digital city.

The research justifications strengthen that the public administration of cities are increasingly using digital platforms in their planning, as

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they provide greater efficiency, lower costs and more transparency in public services. With the use of technology, citizens can obtain more efficient information and services (LEITE; REZENDE, 2010).

The development of cities also occurs in order to obtain better communications (CASTELLS, 2006; GRAHAM; MARVIN, 1996). In this way, technology opens up new perspectives in cities and in the public space where users can interact and communicate AURIGI, 2005).

In order to analyze whether these considerations have occurred in the city of Barcelona, it was decided to analyze it, since this city is among the cities of the world that are closest to the materialization of the concept of Intelligent City (BOUSKELA et al., 2016, pp. 109). Barcelona was chosen in 2014 as the European Capital of Innovation, and its merits are recognized as a productive city, which improves its management through technology. The city also has a network of citizen initiatives that use available technology to organize and try to solve some of its needs, creating a more democratic and connected environment (MOBILE WORLD CAPITAL BARCELONA, 2016).

Technology, in the midst of a culture of generalized connection, enables forms of social mobility and appropriation of the urban space (CASTELLS, 2006; LEMOS, 2005).

A city becomes more efficient in that it is able to obtain data generated in the environment, in the installed infrastructures (by service providers) and in the buildings and streets (by the people), being able to process this data and transform it into information that allows to make decisions that can mitigate, organize, anticipate or anticipate innumerable urban challenges (BOUSKELA et al., 2016; CASTELLS, CARDOSO, 2005).

2 Theoretical foundation

2.1 Digital planning of the city of Barcelona

Cities, as well as the various segments of contemporary society, have undergone major transformations and transfigurations with the arrival of new technologies (SANTOS, 2014).

The old and new technologies are linked and, as a result, end up generating differentiated practices and a complex transformation in several areas of the city, such as urban planning and design. Technology makes possible the spatial transformation from its interventions in diverse scopes, such as the forms of spatial perception, experience, appropriation and planning. Global cultural and economic trends can be interconnected by the digital layers embedded in the physical space (GRAHAM, 2005).

As a result, the media are fundamental to inform society about all the issues, events and events that permeate the social and political milieu. For Polistchuck and Thirty (2003: 63), "communication is a human action whose purpose is to interpret events, to understand the facts of the world and to seek meaning for things". For this to occur, the Internet of Things (or Internet of Things) is required, which, according to Lemos (2013), is a set of networks, sensors and objects linked by computerized systems, which allow the expansion of communication between people and objects, having the ability to interconnect in an autonomous, automatic and context-sensitive way.

The citizen who uses a smartphone can be considered an urban sensor in real time and increasingly interested in getting involved in the affairs of the city. Once the information technology infrastructure in the cities is established, it becomes part of the urban fabric. Therefore, we need to add a layer of applications and communication systems that can function as interfaces between management and citizens and the different structures and departments of cities. Thus, these communication interface systems can serve as collaborative platforms, with the creation of mobile applications that allow data collection and participatory management by the citizen and also allow the city to communicate with users (BOUSKELA et al., 2016).

At the service of citizen participation, in many cities, the increasing use of digital platforms accessible via the web or via smartphones integrates the citizen in the various spheres of public administration, from the request of services to the monitoring of the accountability of municipal management. Barcelona provides ICT - Information Technology and communication to the vast majority of its citizens, incorporating services based on technology to improve city management and the relationship with citizens. With the final objective that the population of Barcelona can benefit from this "digital phenomenon" (MOBILE WORLD CAPITAL BARCELONA, 2016).

2.2 Strategic digital city

The strategic digital city (CDE) provides tools that improve the internal processes and public services provided to society (such as connectivity, information availability, technology, monitoring, infrastructure) that promote the participation of the population (REZENDE, 2012).

The technological and social changes of the information age, which created the conditions for its emergence, happened when the contemporary city established itself as a city-world in the post-industrial era, from the 70s and 80s (Lemos, 2005). Thus, it is possible to affirm that the technologies that favored the emergence of the digital city also led to the emergence of CDE.

On the other hand, Lévy (1999) reports that technology is a determinant, and not a determinant, of society and culture, since it itself is produced within a culture. On the other hand, technologies change the trajectory of social events, changing the local culture. From existing knowledge emerges technological innovation, which is a social phenomenon that begins with a local need, and then solve a universalized obstacle, according to Lévy (ibid.).

The technical literature of the area relates the digital city to the collection, structuring and provision of information by digital means so that citizens can interact with each other and with the government, interconnecting them in the digital network of a given territory. Consequently, this network can enable the integration of technological resources and can make public services and information available in different virtual realities of the urban space (REZENDE, 2012).

Regardless of the difficulties encountered in implementing digital cities, they bring contributions to the government and citizens. Moutinho (2010, 79) reports that "despite obstacles and implementation difficulties, digital city projects have started an inexorable process of municipal modernization with positive effects on the quality of services and access to ICTs".

It can be observed that the concept of digital city and strategic digital city surpasses the universe of the Internet and its users, since it allows, in addition to access to the Internet, social and digital inclusion. However, even though the physical and digital infrastructure is important, the citizen needs to be involved and motivated in the processes of both the government and the municipality to benefit from the privileges that are made available. For this, it is important that the new technologies are disseminated to the citizen in order to arouse their interest and motivation (TANCMAN, 2004).

This scenario opens space for the emergence of the digital city as a system of intelligent and receptive places, saturated with programs and silicon, interconnected and interrelated (MITCHELL, 2001, p. Lemos (2004) also points out that the propagation of the technologies is given at very high speed with potential for infiltration and omnipresence, being able to act in a subtle and at the same time radical way in the spatial and cultural environment. Thus, people can play a very important role as beneficiaries and participants in these transformations through the active use of mobile devices and applications, which facilitate monitoring and collaboration with the policies of their rulers, according to Bouskela et al. (2016). It is possible to reach an advanced community model defined by Lemos (2004), in which the new ways of interacting with the environment materialize through information and communication technology.

2.3 Relationship between the digital planning of the city of Barcelona and the strategic digital city

The development and urban planning of cities are usually related to the needs of the population. Thus, technology and strategy become important factors to accompany the pace of transformation of society and consequently meet the needs of the population to relate to municipal decisions.

However, as was argued in previous chapters, government actions have been influenced by technologies and strategies, as these tools provide access to information. Being noticeable that the uses of these tools have become useful for a better relationship between citizens and rulers.

As a result, information technology is being used as a resource in city halls that allow the urban environment to become more and more connected with citizens. Thus, the growing use of information technologies in this context makes possible new forms of interactivity, becoming a more communicative medium, which opens up a range of new perspectives.

The digital planning of the city of Barcelona uses information technology and strategy, which are part of the CDE components. These are moderators so that users can take advantage of the technological benefits, contributing to digital inclusion. The technologies allow an increased capacity for interaction with the environment and, thus, the citizen is included in a physical and digital way in the context of the city.

Therefore, city management can be aided by the use of technologies and strategies, so that relations between citizens and city administrators become more effective. The relationships between strategy and information technology, which are part of the pillars of the CDE, help provide individuals with tools for improvement in cities.

3 Research methodology

The selected scientific method was the case study carried out in the city of Barcelona (SILVA; MENEZES, 2005; GIL, 2010; YIN, 2010). As for the research techniques, the following procedures were used: bibliographical and descriptive survey for the bases of the theoretical foundation; the nature of the research instruments: qualitative method for the data collection in the city of Barcelona; qualitative approach to data and information analysis; identification and formulation of the problem; delimitation of the case unit to be studied; delimitation of the number of case studies; and formulation of the research protocol (SILVA; MENEZES, 2005).

The phases of the research clarified how the structures of the study project that were developed were prepared: preparation; data collection and analysis; documentation of results (GIL, 2010).

The survey, chosen for convenience (GIL, 2012) was Barcelona and took into account that this city has a network of initiatives that use the technology and the strategy to create a more democratic and connected environment. For this purpose, the content analysis of the sites was used as observation unit: ajuntamente.barcelona.cat; barcelona.cat; governmentbert.bcn.cat; which are relevant to the theme of this research (MARCONI and LAKATOS, 2010; YIN, 2010).

4 Analysis of the digital planning of the city of Barcelona and its relations with the strategic digital city

4.1 Analysis of planning and the digital city

The analysis of the digital planning of the city of Barcelona is based on the principle that both the CDE and the digital planning of the city of Barcelona have as one of their foundations the strategy and the information technology for the benefit of the citizens. The management of cities with the help of new technologies and strategies is a global trend, helping to make relations between citizens and city administrations easier and more transparent.

a. Analysis of the digital planning of the city of Barcelona

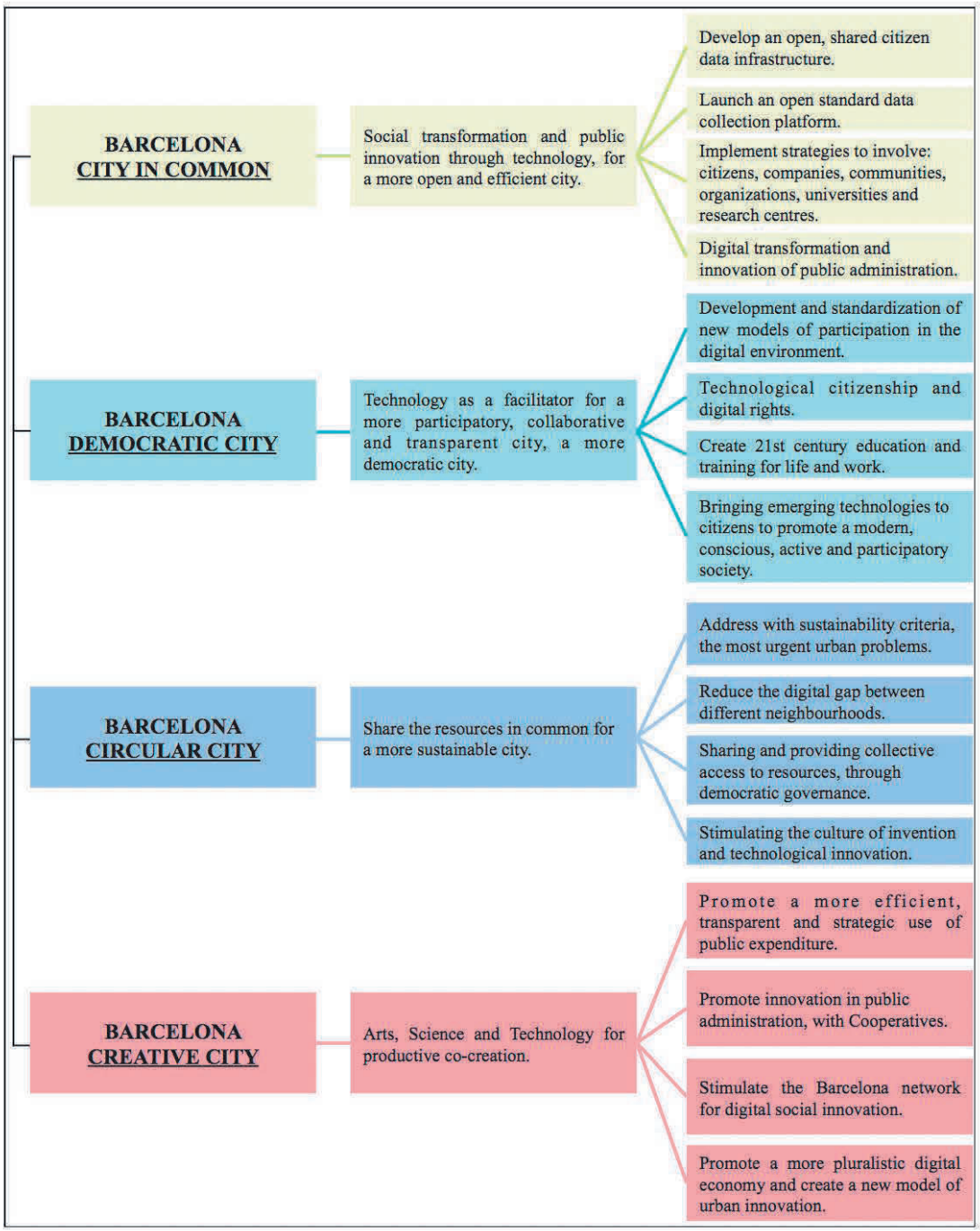
Barcelona is identified by intelligent management, able to respond quickly or even anticipated to the needs presented by its citizens (AJUNTAMENT DE BARCELONA, 2017).

The term "digital cities" has been used as a contemporary expression of an urban ideal that adds a better quality of life, information, communication and efficient management of services and pubic spaces. Thus, the use of strategies and information technologies serves as a

platform to facilitate information and communication. Therefore, the digital city addresses the possibility of providing public services and information to citizens in broader virtual realities (REZENDE, 2012).

This intelligent management, in an attempt to improve the quality of life of citizens, has drawn up the "Barcelona City Digital 2017-2020" plan. This plan, presented in October 2016, is a municipal road map to promote the technological sovereignty of citizens, in order to allow a new model of urban innovation and promote a more pluralistic digital economy. It is based on the transformation and digital innovation of the public sector and of companies, government, universities, communities and organization of people with clear public leadership and citizen.

Figure 1 - Scheme of the Barcelona City Digital Plan 2017-2020



Source: the author (2017), based on data from the *Ajuntament de Barcelona* (2017).

Consequently, Barcelona City Digital is based on four pillars, as shown in Figure 1, which are: Barcelona city in common, which deals with social transformation and public innovation through technology, for a more open and efficient city; Barcelona is a democratic city that focuses on technology as a facilitator for a more participatory, collaborative and transparent city, that is, for a more democratic city; Barcelona circular city, which raises the questions about sharing common resources for a more sustainable city; and Barcelona creative city, which points the questions about the arts, science and technology to productive co-creation.

The CDE is based on information technology, information, strategy and public services, which are the pillars of this concept, as shown in Figure 28. Thus, CDE provides tools that improve internal processes and public services provided to the society, such as connectivity, availability of information, technology, monitoring, infrastructure and the promotion of population participation. The CDE results in a series of benefits to the population, among which we can highlight the increase in the quality of life with the provision of services through the internet, through the participation of the citizen in the management of the city and the consequent contribution in the administration of the rulers (REZENDE, 2012). Therefore, the concept of CDE is related and can be identified in the Barcelona City Digital Plan 2017-2020.

b. Analysis of information technology

The Barcelona Digital City 2017-2020 plan is based on technology as a more accelerated means of social change and public innovation. This opens a range of new perspectives in cities and in the public space, since users can interact and communicate. Thus, technology enables beneficial transformations in physical and digital mobility (AURIGI, 2005). Thus, technologies change the trajectory of social events, changing the local culture from existing knowledge. In this way, technological innovation emerges, which is also social, starting with a local need and, in the end, solving a universalized social obstacle (LÉVY, 1999).

With the application of TIC, Barcelona Digital City intends to develop a data infrastructure of the city that is open and possible to be shared, as well as develop a strategy involving citizens, companies, communities and universities, with some well-defined policy lines democratization.

Technologies and therefore information technology are increasingly present in people's lives. Despite this, there is still a part that does not know or have not discovered the potential of these technologies and information technology, and it is possible to report that these people should not be aware of their rights in this area.

The municipal government of Barcelona has the ambition of increasing the digital domain of its citizens, allowing them both the possibility of having the digital and technological domain as the tools to be able to fully exercise their freedom and their digital rights. In order for Barcelona residents to achieve this technological sovereignty, the municipal government of this city has stimulated debates on this subject and tries to involve the interested parties. Thus, this government promotes open spaces for debates and opportunities for citizens to discuss and submit proposals on the city's technological strategy.

c. Analysis of strategies

The strategy can be understood as a means, a form, an activity or a way to meet the municipal objectives (REZENDE, 2012). The Barcelona City Digital Plan has the specific objective of improving the aspects of government and city; companies and social organizations; and citizenship. This plan aims at the agile and open transformation in the public administration. This digital transformation is a strategic project promoted by the Municipal Communication Institute, which aims to improve and streamline management processes and services for citizens, using information technology to benefit the inhabitants of Barcelona. To this end, the project includes the establishment of open standards for digital services and the optimization of strategic projects of the mandate of the current government, as well as their adaptation to the new framework and the regulation of digitization of the public sector. Including development, ensuring that TIC applications evolve appropriately to support all projects under this plan.

Nevertheless, the Barcelona Digital City Plan aims to provide, in a strategic and progressive way, all neighborhoods (districts) of the city infrastructure, resources, incentives and programs. In this way, each community, neighborhood or district can have resources available to enable citizens of all ages and conditions to make technology a means for improving public services and for more equitable and sustainable economic and social growth. As rapid changes in the social environment occur, it becomes evident the need for studies in the formulation of strategies, in the actions for decision-making and in the most effective solutions for city administration (OLIVEIRA, 2005). The strategy can be a standard or plan that integrates with the main goals, policies and sequences of action of the organization as a whole and, when well conceived, can contribute significantly (QUINN, 2006).

5 Results between the digital planning of the city of Barcelona and the digital city strategic

The development and digital planning of Barcelona are related to technology and strategy in an intrinsic way. These became indispensable factors for this city to follow the pace of transformation of society. Thus, based on the previous analyzes of this research, it was possible to report how the relationship between the digital planning of the city of Barcelona and the strategic digital city happens.

The relationship between city strategies and information technology, which are part of the CDE concept, helps provide individuals with innovative tools for city improvements between rulers and citizens. Enabling an increased interaction capacity with the environment, since the citizen is now included in a physical and digital way in the context of the city, with digital inclusion, where users can enjoy the technological benefits.

Barcelona aims at the digital transformation of the city by using the technology of information through strategic projects, which aim to improve and streamline management processes and services to

citizens, using information technology and strategy to benefit the inhabitants of Barcelona. Thus, information technology and, consequently, strategy are increasingly present in the lives of the people of this city. Nevertheless, the digital planning of the city of Barcelona is close to the concept of CDE, since both this planning and the CDE have as one of its foundations the strategy and the information technology for the benefit of the citizens. The management of the city is aided by the use of technologies and strategies, and this is a worldwide trend, so that relations between citizens and city administrators become more transparent and effective.

6 Conclusion

Through this research, it was possible to verify that the digital planning of the city of Barcelona is used in this city effectively, because it is possible to recognize that the strategy and the information technology make possible the interface between the population and the government. It is clear that the Barcelona government prioritizes information and communication issues in city planning. Physical and digital displacement becomes more and more important in this scenario. It was also possible to perceive that the information technologies make possible the spatial transformation from their interventions in the urban environment. However, it was possible to note that this city owns and uses the four pillars of the CDE concept, which are information technology, information, services and strategy, as a means to meet the municipal objectives.

The objective was achieved insofar as the analysis of the digital planning of the city of Barcelona and its relations with the strategic digital city was elaborated.

The results obtained through the analyzes have shown that the digital planning of the city of Barcelona provides information technology and strategy resources that promote practices intrinsic to the strategic digital city, showing that the city of Barcelona applies these resources to the benefit of its inhabitants, making with which this city is increasingly democratic and digital. The analyzes demonstrate how digital planning can be aided by the strategic digital city project, confirming that the population would be increasingly benefiting from the technological and strategic resources.

The present research opens space for managers and citizens of Brazilian cities to also reflect on the use of information technology and strategy in the management of municipalities. In this way, people can realize that it is possible to use as an example the way in which the management and the citizens of Barcelona make use of these tools of information technology and the strategy for the own benefit. The research presents some limitations, as far as the methodological procedures used, one of the limitations of this research is the use of a single case study, so that the results obtained in this research cannot be generalized to other cities.

The research, besides contributing with the studied city, Barcelona, can also contribute with other cities, since the analysis can be configured as a source of consultation so that other cities make a self-evaluation of the use of information technologies and the strategy in the municipal system. These tools are used to work with the concerns and the changing conditions surrounding municipal governments being addressed within the concept of strategic digital city with the intention of transforming ordinary citizens into digital citizens. Reiterating that a city is better managed as it is well planned, increasing the quality of life of its citizens and enabling the interface between the population and the government, as the case studied.

Acknowledgments: CNPq Brasil (Productivity research scholarship).

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Governance structure promoting innovation: an exploratory study in Brazilian habitats

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Abstract: This research aimed to investigate how the governance structure of innovation habitats may contribute to the development of innovation in resident companies. An exploratory study was conducted in INOVAPARQ and CELTA incubator, in Brazil. The empirical contexts were investigated by applying qualitative method with NVivo software. Critical success factors of governance were found: managerial relationships with different stakeholders; national and international training networks; and boosted resident companies monitoring by specific assessment tools. It was concluded that these factors are crucial to the innovation process of resident companies mostly by creating new products and services; sharing of inter-company knowledge; and motivating employees to work in a creative environment.

Keywords: Absorptive Capacity; Innovation Habitats; Governance Structure

Submitted: August 20th, 2018 / Approved: November 13th, 2018

Introduction

This research aimed to investigate how the governance structure of innovation habitats may contribute to the development of innovation in resident companies. Moreover, how the structure of this governance scenery may stimulate the management council capable of presenting effective guidelines for the innovative development of the enterprises. We argued that such development should reflect at least effectiveness by sharing strategic resources (Robeson & O'connor, 2007; Mattor et al., 2014, Filipova, Drozen & Kubankova, 2016, Kapounek & Krutilova, 2016).

Environments of intense exchange of experience can lead to the acquisition, transformation, assimilation and application of knowledge from new insights, which may lead innovations towards the market (Zahra & George, 2002, Fosfuri & Tribo, 2008, Caner, Sun, Prescott, 2014, Xie, Wang & Zeng, 2018). As a result of this dissemination of information and knowledge, these actions can, due to the outlined strategies, minimize the impact of external forces on the environment and create innovations that could enhance the society with new services or products. Innovation habitats environments, that aim to boost productivity and innovation of resident enterprises, perform as agents of information and knowledge transfer for the promotion of new business and generation of new ideas (Stopper, 1995, Tonelli & Zambalde, 2007, Fallows, 2013). Those may be able to become specialized in a particular industry, such as information technology, in which stakeholders may create specific services or products to attend market and society (Zouain, 2003, Mills, Reynolds & Reamer, 2008, Virtanen, Heimonen & Sepponen, 2014, Sureeyatanapas, Poophiukhok & Pathumnakul, 2018).

There are distinct governance arrangement models for innovation habitats and it is relevant to understand how different structures of governance can optimize actions to support the business and the technology transmission towards innovation (Ma, Kaldenbach & CI, 2014, Wang, Chan & Fang, 2018). Therefore, it is necessary to clarify how different governance actions can effectively contribute such to the process of innovation as to the sustainable development of resident companies.

The stakeholders in innovation habitats promote the sustainability of their business by the promotion of innovation, on which the governance structure pursues contributing to the arrangement of partner's networks that are able to work with synergy and achieve common goals (Humphrey, Schmitz, 2000, Mueller, Schmidt & Kuerbis, 2013, Vega-Jurado, Kask & Manjarrés-Henriquez, 2017).

Beyond the understanding of how the development of governance structure in innovation habitats can countersign the creation of absorptive and innovation capabilities in enterprises, it is also discussed the development of governance actions creating an adequate structure focused on knowledge exchange and innovation within and among companies.

Theoretical Background

Governance Structure

The study of governance and its possible applications in management have been monitored and improved in recent decades, especially in developed countries, highlighting the United States and Britain practices. Hence, literature, laws, social customs, modes of governance, organizational forms, and industry structures are compared in terms of their incentives, economic consequences, and ability to survive and grow in a given historical setting or technological context (Baldwin & Von Hippel, 2011).

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ISSN: 0718-2724. (http://jotmi.org)

However, the formation of innovation habitat enhances specific subject knowledge, in which the competitive governance structure construction insertion passes through the establishment of the structure, elements and governance actions. Also, in this context, Schmidt and Balestrin (2015) investigated the collaborative R&D network in innovation habitats proposing that such environments devise a strategic role in providing services and infrastructure to support collaboration, innovation and development of resident companies.

The governance structure denotes actions developed by a behavioral perspective. Factually, governance is related to mechanisms designed to control the resources of companies, based on key stakeholder's management interests of that influence companies through their proportional interests to applied resources and desired returns (Groenewegen, 2004). However, it is necessary to accompany all governance changes that occur during the growth stages of organizations (Bernstein, 2012).

Governance can also be understood as a plural and integrating concept, which differs from the concept of management. It translates into joint agents, businessmen, third sector, governments of various levels and other segments of society, able to be represented in projects and plans related to a utopian city with quality of life and, also, a broad sustainability or shared leadership (Kaufmann, Kraay & Mastruzzi, 2006). This includes the process by which governments are selected, monitored and replaced; the capacity of the government to effectively formulate and implement sound policies; and the respect of citizens and the state for the institutions that govern economic and social interactions among them. Also, this process is the result of a constant and effective dialogue between the government and civil society to create institutional spaces of political decentralization, interfering with the practice in training managers who will work the front organizations (Kaufmann, Kraay & Mastruzzi, 2018).

Practically, it can be eminent that governance structures are created to quickly remedy current problems and future. By developing the effective governance system, problems such as slow decision-making process, due to bureaucracy and incomplete organizational structures can be solved in a more dynamic interpretation of the market and thus make the company more competitive.

In communal environments, governance needs to be analyzed under three joint perspectives: influence of the agents; agility in decision making; and accountability (Bobbio, 1987). Those agents are the actors who will constitute the governance of a particular organizational structure need. This structure, though, is composed in order to have power to influence actions to be implemented, have good relationships and dynamism facing an agile decision-making process. In the governance's arrangement process, one can still check agency problems (Saito & Silveira, 2008) related to conflicts between shareholders and managers.

Those conflicts are caused by socio-cultural shocks and organizational models consist of rules, specific rules and routines. To alleviate this "clash", it is needed to establish and provide clear guidelines that are known to all stakeholders (Scott, 1987, Scott, 2004 & Adegbite, 2015).

Many innovation systems studies regarding innovation habitats consider institutions often change slowly. And, so, the generation of innovation may be affected considering the dependence that exists between organizations and institutions (Werle 2011, Pipan, Gomiscek & Mayer, 2012). In other words, slow institutions and lengthy decision-making processes involve less innovative and less degree of competitiveness. Also in this context for organizational development, the balance of strength and power industry with their companies is required.

We consider that the governance structure should encourage the development of a capable management council to provide effective guidelines for the innovative development of enterprises. This may reflect the creation of absorptive capacity and innovation capacity, designed from the sharing of strategic resources (Robeson & O'connor, 2007, Mattor et al, 2014).

From this conceptual analysis, we present the theoretical proposition 1 as follows: the governance structure of an innovation habitat contributes to the process of innovation in resident companies.

Absorptive Capacity

Firstly, we analyzed the concept of absorptive capacity as necessary to obtain records assuring that this field of application theory addresses the capabilities of companies or individuals to use organizational resources to generate products or services. In these terms, companies or individuals must be able to make something out of the conditions and targeting factors are needed to reach a particular purpose (Zahra, Sapienza & Davidsson, 2006).

In a practical way, the development of different capacities by companies allows them to explore new market opportunities from offering unique products and services. Thus, Table 1 identifies six types of capabilities arising from the internal and external environments. These capabilities interface with organizations and their knowledge presented in the experience and in its life cycle (exploration, retention and exploitation). They can be defined as: inventive, absorptive, transformative, connective, innovative and disruptive (Lichtenthäler & Lichtenthäler, 2010).

Table 1. Interfaces of knowledge. Data from Lichtenthaler and Lichtenthaler (2010).

	Knowledge Exploitation	**Knowledge Retention**	**Explicit Knowledge**
Intern (Intrafirm)	Inventive capacity	Transformative capacity	Innovative capacity
Extern (Interfirm)	Absorptive capacity	Connective capacity	Disruptive capacity

By analysing Table 1, we understood that the capacity and the organization's ability to create, or expand or modify its resource base, both internal and external (Lichtenthäler & Lichtenthäler, 2010).

Regarding absorptive capacity, measure these ability is still a challenge for researchers and companies (Flatten et al, 2011), regarding the fact that a valid measure that incorporates the various dimensions of

absorptive capacity has not yet been developed. This may occur, for example, that the definition of metric often arises in the result of a no consensus regarding the dimensions that compose the construct, resulting in the need to introduce which model absorptive ability is being adopted in the search.

Moreover, Schreyöegg and Kliesch-Eberl (2007) also claim that for a company to be innovative is also expected that it has a minimum capacity set to run its core activities, seeking mature and evolve in pursuit of innovation. This innovation is focused on the process and not isolated events, including the implementation of changes in products / services, organizational and managerial processes and systems (Veugelers, 1997, Veugelers & Cassiman, 2000, Schreyöegg & Kliesch-Eberl, 2007).

Thus, considering the importance of the strategic use of internal resources of the company to contribute to the process of innovation and development of its capabilities (Cohen & Levinthal, 1990, Zahra & George, 2002, Lichtenthäler & Lichtenthäler, 2010, Flatten et al, 2011), it is necessary to introduce some definitions regarding strategic resources.

Initially, Teece, Pisano and Shuen (1997) conceptualize resources as the strengths that companies can use to design and implement their organizational strategies, resulting in innovative products or services. In this case, an analysis based on internal resources is important to identify a sustainable competitive advantage derived from dissatisfaction and/or failure of external action contributions or relationship with the environment in business development (Foss, 1997). The resource-based perspective also seeks to understand which existing conditions are able to generate income or lasting competitive advantage (Barney, 1991, 1995, Peteraf, 1993, Amit & Schoemaker, 1993, Barney & Hesterly, 2012).

Thus, valuing the adopted strategies, improve business performance in a high degree of unpredictability and dynamic environments and provide a privileged position within its operating environment can result in a more effective innovation process (Maurer, Bansal & Crossan, 2010).

In order to develop harmony and effectiveness in the system generated by a given habitat, it is necessary that its strategic resources, as well as the resident companies, are constant in line and assist in capacity building, since companies with resource problems and difficulties in developing the skills can result in low value-added innovation and a limited competitive potential.

Specifically, considering the absorptive capacity as a result of the strategic management of resources, Zahra and George (2002) point out that it can be turned to "potential absorption capacity", including the acquisition of knowledge and assimilation capacity, and the "absorption performed capacity", which has its heart in the transformation and exploitation of knowledge. It should be noted that the strategic resources represent knowledge that is being worked on.

There are other empirical studies on the relationship between the variables of absorption capacities and efforts to innovation, on which there is evidence that they are positively correlated (Cohen & Levinthal, 1989, 1990, Veugelers, 1997, Becker & Peters, 1998). Emphasis is also given to the fact that the present absorption capacity of a company depends on the efforts it made to innovate in the past (Cohen & Levinthal, 1990).

Finally, the concept of absorptive capacity in this research is the actions target at acquisition, transformation, assimilation and exploitation of knowledge, in which the company depends on the absorption capacity of its individual employees and the form in which it will be developed in search to effectiveness.

From this conceptual analysis, we present the theoretical proposition 2: the absorptive capacity of companies' resident in innovation habitats contributes to innovativeness in products, services or processes.

Innovation capacity

The process of creating an environment driven to innovation is vital in the development of enterprises and the generation of products and services that meet the interests of society and the market, however, the understanding of this environment goes, at first, the meaning of innovation. Since Schumpeter (1997), innovations represent new combinations: marketing techniques translated by new business combinations; and organizational, in the form of new business organizations. Innovation may be related to the exploration of opportunities for companies delineating precisely the borders that delimit the space of each niche market, so as to improve and meet underserved market for new services (Pavitt, 2004).

The variables - time and speed - are strategic elements for companies seeking competitive advantages of experience in the market (products or differentiated services). And considering the pressures and needs of society and the market, are also essential to the process of innovation, as the life cycles of products and the time of its developments are increasingly short, in a scenario where the customers expect service and prompt delivery of products (OECD, 2005).

In this context, characterized by intense competition and market pressures increasing, it is recorded that the intensity of competition, rapid globalization and the constant changes in information technology make the inevitable innovation for businesses as a way to capture opportunities through the development of new products and the market itself (Hauknes, 1998, Lobianco & Ramos, 2004, Kubota, 2009). Innovation processes may be aimed at generating knowledge based on strategic models that consider social and economic aspects, stimulating networking activities, avoiding isolated organizations (Hauknes, 1998, Lobianco & Ramos, 2004, Kubota, 2009).

Thus, innovation can improve company performance by optimizing their ability to innovate and improve management processes of production, considering the application of new organizational practices and the development of entrepreneurial skills to acquire and generate new knowledge (OECD, 2005).

In this investigation, the concept of knowledge is understood as the strategic use of data and information, through the application of methodologies and specific technologies. It allows people to develop innovative products and services that may be applied due to society's demands or market opportunities (Van De Bosch, Volberba & Boer 1999, Zahra & George, 2002, Fabrizio, 2009). So, it is understood innovativeness as developed behavioral actions and managed by companies, which potentiated by an environment that stimulates the generation of innovation, resulting in the creation of new products, services or in the improvement of processes.

However, in innovation habits environments some behavioral principles may restrict the innovation capacity of enterprises, and for this reason, companies will be called upon to develop their capacity to adapt to the early stages of development, such as, in conducting a project related to the understanding of new potential markets and customers. So, they can adjust to anticipated future demand mode (Biedenbach & Muller, 2012).

In conclusion, from this conceptual analysis, we present the theoretical preposition 3 to be investigated: the absorptive capacity and innovation companies can be influenced by strategic actions of actors in the governance of innovation habitats. Before this, confirmed the demonstration of theories used for the analysis of the collected data, it is understood that the innovation habitats governance structure may represent a strategic factor in helping the resident companies in formulating strategies and generation of innovation through knowledge sharing among different stakeholders.

Method

Procedure, Subjects or Participants

Empirical studies conducted in Brazil have been applied in two prominent innovation habitats in national scenario and in Santa Catarina during the second half of 2015 and sought to expand knowledge with theories applied. Two cases were investigated: The Technological Innovation Park of Joinville and Region - INOVAPARQ and Business Center for Advanced Technology - CELTA.

INOVAPARQ is located in the city of Joinville, the largest city in the state of Santa Catarina, and came up with the goal of providing environments conducive to the practice of innovation, demand has increased more in the north of Santa Catarina (INOVAPARQ, 2015). Regarding the choice of resident companies representing INOVAPARQ habitat, Table 3 summarizes the main characteristics of the investigated companies.

Table 2. Total of INOVAPARQ companies and companies investigated.

Number of companies / Practices Areas	Software Development	Biotechnology and environment	Others
Total of 20 companies in INOVAPARQ	12	3	5
Total of 8 investigated companies	5 companies = EIP3, EIP4, EIP6, EIP7 e EIP8	2 companies = EIP1 e EIP5	1 company = EIP2

In addition to the 8 investigated companies were interviewed three managers of INOVAPARQ, totaling 11 interviews. Regarding habitat interviews the CELTA, which is located in Florianopolis, SC, Table 4 summarizes the main characteristics of the investigated residents' enterprises.

Table 3. Total companies in the CELTA and companies investigated

Number of companies / Practice Areas	Software Development	Product Development	Others
Total of 28 companies in CELTA	10	10	8
Total of 9 investigated companies	5 companies = EC1, EC2, EC3, EC4 e EC9	2 companies = EC6 e EC7	2 companies = EC 8 e EC9

Finally, it is noteworthy that in addition to the 9 investigated companies, were interviewed one CELTA managers, the principal manager, totaling 10 interviews in this habitat

It is important to point up that both innovation habitats investigated, INOVAPARQ and CELTA, can be regarded as national and international references in relation to their innovation environments and support geared to business development, highlighting, for example, the combination of both habitats to the national Association of entities Promoting Innovative Enterprises - ANPROTEC and the international Association of Science Parks and Areas of Innovation - IASP, these large national and international entities expression.

Apparatus

For the analysis of the contents of the interviews, it was used the qualitative analysis software Nvivo 10, produced by QSR International. The software resources applied were: word counting and the network crossing of similar words present in the interviewees' speeches.

Finally, from the use of NVivo software, it can be performed the entire process of encoding and lexical analysis of the data, which facilitated the process of analyzing the extracted contents of the interviews; each collected information was tabulated considering the constructs and categories drawn from the framework.

Design

Faced with this empirical research context, it was identified as a research problem: **How can the governance structure of an innovation habitat contribute to the development of the absorptive capacity and the innovation capacity of its companies?**

Thus, the theoretical propositions were assumed that guide the development of this research:

I. the governance structure of an innovation habitat can contribute to the development of capacities in companies.

II. the absorptive capacity of companies in innovation habitats can contribute to their capacity to innovate in products, services or processes.

III. the absorptive and innovation capacities of companies can be influenced by the actions proposed by the governance structure of innovation habitats.

For analysis and validation of the presented propositions, categories of analysis (Table 4) were identified in order to better understand the theoretical proposed model.

Table 4. Constructs, categories e indicators of analysis – theoretical framework

Constructs	Categories	Indicators of analysis
Governance	Organizational structure	Legal model; Board activities and structure, Stakeholders; Management model
	Mechanisms of growth	Internal and external actors; Capacity building; Physical structure and shared services.
	Technology, innovation and networking	Relationship with the market; Networking cooperation; Technologies and physical spaces; Financing and allocation of resources
	Sustainability	Economic / Financial; Social; Environmental
	Opportunities for international relations	Integration with global markets; Participation and holding of events; International partnerships.
Absorptive capacity	Acquisition of knowledge	Events; Internal Networking; Business networks.
	Assimilation of knowledge	Conduction of meetings; Training and capacity building; Performance benchmarking
	Knowledge transformation	Process innovation; Past experiences; Technologies.
	Application of knowledge	Customer numbers; Patents; Recognition; After sales
Innovation Capacity	Stimulus to innovation Costs	Costs; Public Notices; Investors; Research and Development.
	Inovativity	Business Opportunities; Adequate environment; Participation policy.
	Technological development	New technologies
	Creation	New products or services;
	International Opportunities	Access to new markets

It should be noted that the categories and indicators of the governance structure construct were developed from the authors Robeson and O'Connor (2007), and Mattor et al. (2014), which were used as the basis for the construction of the semi-structured questionnaire that was applied in Brazilian innovation habitats. Considering the categories and indicators of the construct of the absorptive capacity, these were based on the authors Cohen and Levinthal (1990), Zahra and George (2002), Fosfori and Tribó (2008) and Flatten et al. (2011). The categories and indicators of the innovation capacity construct were based on the following authors: Lichtenthaler and Lichtenthaler (2010), Chao et al. (2011) and Biedenbach and Müller (2012).

Results

Initially, it had been investigated the Technological Innovation Park of Joinville and Region - INOVAPARQ, which represents an important innovation habitat located in the city of Joinville, State of Santa Catarina. This park was created with the purpose of developing technology, economy and social aspects of northern Santa Catarina region by structuring and managing an environment that potentiate the scientific and technological research activities, technology transfer and the introduction of innovation in production and social environments. Also, aiming at favoring the creation and consolidation of projects to assist the development of new technologies, products and processes (Inovaparq, 2015).

Among the activities planned by INOVAPARQ management committee, provided in the statute, it is highlighted those related to the development and innovation of businesses, as well the whole system:

- Encourage and cultivate innovative entrepreneurship;
- To promote favorable conditions for the attraction of qualified human resources;
- Establish or contribute to cooperation and partnerships between educational and research institutions, companies, government agencies, agencies and national and international organizations;
- To support and enable operation on their premises or outside, enterprises focused on research and development of products, processes and / or services with potential for innovation; and
- Search environmental sustainability in their activities and encourage the rational use of natural resources and clean technologies in enterprises installed on it.

It can be seen from these actions that, in some way, it may be related to activities that include functions of a habitat of innovation, as has the theoretical approach in the literature. For example, as portrayed Groenewegen (2004), governance is related to the creation of

mechanisms aimed at the resources of the enterprise control from the management of the interests of key stakeholders, considering the resources applied and desired returns.

It should be noted that the current INOVAPARQ physical space is new, opened in August 2010 and has been receiving updates and investment in recent years. The current location of this park occurs because of land donated by the municipality of Joinville, and this space will also get in the coming years, the Innovation Center Joinville.

From what can be understood as critical success factors of INOVAPARQ governance, we presented a proposal for the realization of these factors that can portray this habitat's governance structure.

Figure 1. Critical success factors of INOVAPARQ governance structure

On Figure 1, the factors represent the search view that will guide the process of scientific research on the INOVAPARQ.

Initially, it is considered that the factor "technology companies" is the main profile of the companies that are installed in this habitat. These companies that represent the type of company most commonly found and incubated, scientific and technological park. The second feature noted from interviews and secondary data were the "partnership and stakeholders" of INOVAPARQ with different relationships, factor this decisive for the development and effectiveness of habitat as a reference environment in their region. The third factor noted was the "methodologies and technologies" used in the development and qualification of businesses, highlighting the CORE methodology, created by CELTA / CERTI Foundation, which helps in the evaluation of incubated companies.

The fourth factor is the "proactivity managers" of INOVAPARQ, this factor mentioned by several companies in the interviews and concerns the constant search for interaction and information transfer and knowledge of managers towards habitat companies.

The fifth and final critical factor found was "ideas generator room" which portrays the search in INOVAPARQ to develop recreational areas, botanical gardens, green areas and other physical spaces that may lead to the generation of ideas by resident companies.

It should be noted on Figure 4 that all features listed are related to the INOVAPARQ governance structure, to list: partnerships, proactive managers and innovative companies that are highlighted elements during interviews and secondary data, in which all these factors can contribute for the development of this habitat. The following information will be presented characterizing the governance structure of the CELTA.

CERTI Foundation - Reference Centers in Innovative Technologies Foundation in 1986 created the 1st Brazilian incubator of technology companies, the Business Center for the Elaboration of Innovative Technologies - CELTA, at the time called Business Technology Incubator - EIT. This incubator, a pioneer in Brazil, search from the beginning to support technology-based enterprises by encouraging and supporting the creation of new businesses. In general data, holds 36 technology-based companies that generate about 800 direct jobs and annual revenues of incubated reaches approximately R $ 70 million (Celta, 2018).

This habitat also launched a system for monitoring and evaluation of companies based on Competitive Intelligence and Knowledge Management. From anywhere in the world the business owner can access the CELTA site and request or monitor their evaluation and can get market information, competitors, customers, products and technologies, which makes the system an important tool in the decision-making process of incubated companies.

These activities developed by CELTA confirm Graham et al. (2003) understanding of the governance organizational model strategic actions, because for these actors are necessary that managers responsible for governance develop activities for the development and business innovation, a fact verified in CELTA.

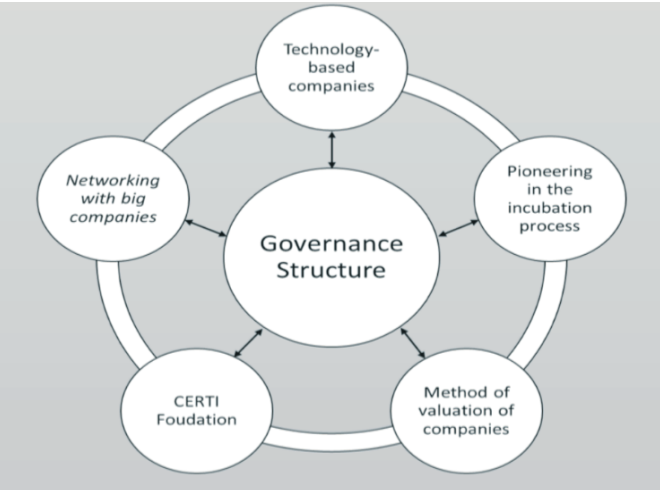
Markman et al. (2009) also have a similar governance model, which for the author can be guided by the identification of interests and incentives aimed at process management transfer of technology both by the management of habitats and by entrepreneurs that environment. These actions, in the specific case of CELTA, make up the search for the relationship of CELTA managers with existing companies through technologies developed.

The CELTA team also worked in the training and licensing of 400 consultants and incubator managers (those who assist incubators in the implementation of CERNE) and support for selection of 144 Brazilian incubators, which received financial support through the SEBRAE notice - ANPROTEC 02/2012 for the implementation of the pilot CERNE.

CELTA has about 28 incubated companies; all installed in their physical facilities, which are located in the Technological Park Alfa, in Florianópolis, SC.

From what can be considered as critical success factors of the CELTA governance structure is presented a proposal for the characteristics to form the structure of this habitat model (Figure 2).

Figure 2. Critical success factors of CELTA governance structure



From Figure 3, explicit that "technology-based companies" represent the profile of CELTA's resident companies, which characterize the type of company most commonly found in incubators and in science and technology parks. The second feature identified concerns the "pioneering incubation process" of CELTA, which is the first incubator in Brazil, and therefore, can represent a national prominent factor in the incubation process.

The third element was the "CERNE methodology for valuation of companies", which was created by CELTA/CERTI Foundation and is currently used for many incubators in Brazil.

The fourth element is the very "CERTI Foundation", an organization that created the CELTA, and also participates in incubator management process, due to national prominence this foundation has in innovation activities, this factor may contribute to CELTA's development and growth.

The fifth element concerns the "Network" that CELTA has and seeks to build with large companies, this factor is pointed out by most of the companies during the interviews as something positive in their relationships with the market and that causes the appearance of new ideas.

Framework of the innovation process in resident companies

The qualitative research identifies specific success critical factors of each case investigated. It is known that these factors are structural investigated for these cases, however, depending on the case being analyzed, it can be revealing as long as there is representation, in other words, represents a benchmark. It is considered that the cases identified in this thesis permit progress in a theoretical proposition. It is recognized that this proposition still cannot be generalized. Thus, it is assumed a theoretical proposition in which should be further investigated through more qualitative research. This research will give conditions for quantitative investigations that confirm the designed model.

The framework proposed (Appendix 1) takes into consideration critical success factors identified in the investigations realized in the cases of INOVAPARQ and CELTA as empirical fields, beyond the exploratory study in the Spanish habitat CPI, looking to present some actions and key-process that applied in the context of innovation habitats can bring a differential development in the company.

According to the suggested structure, it can be seen that the actions related to the governance structure of innovation habitats, as well as the actions taken by companies in developing their absorptive capacity and innovation, that can take place in a systematic and related to each other.

In a global vision, it can be proposed with the analysis carried out in both cases studied that the contributions made by each innovation habitat indicate that governance actions contemplated in its structure and, when they are well executed, can enhance the development of absorptive capacity and innovation companies, a fact that is in line with what has been presented in the literature (Robeson, O'Connor, 2007; Zahra; George, 2002; Phosphoric, Tribe, 2008; Lichtenthäler; Lichtenthäler, 2010; Biedenbach; Muller 2012 ; Mattor et al, 2014).

Furthermore, the model (Appendix 1) depicts that this framework is not a closed system because the results achieved may be used as feedback by habitat managers, to design new actions and reform to those already existing.

Also in this framework, it had been tried to present critical success factors of all 14 categories developed from the three theoretical constructs in which, for each category defined in the theoretical model, it is identified representative actions of a determiner indicator.

For example, for the category "growth mechanism" the construct governance structure, it was presented an action related to the indicator development capabilities, in other words, the activities of monitoring and evaluation carried out by innovation habitats.

It is worth mentioning that the actions selected for the framework was considered the joint analysis of the two cases investigated, and from that, identify shares for both cases. That is, both the INOVAPARQ as to CELTA, for example, the relationship promoted with different stakeholders can contribute to the development of the absorptive capacity of companies.

It also emphasizes that every action presented by the governance structure of a given innovation habitat may be related to any activity undertaken by resident companies regarding the development of its absorptive capacity. Similarly, absorptive capacity of action may be related to any activity aimed at the development of their innovation capacity.

In other words, it can report, for example, that the formation of national and international networks promoted by innovation habitats can contribute to the exchange of experiences of companies, and can also strengthen the credibility of the habitat, in order to help resident companies' new business development and the search for new markets.

Discussion

The aim of the research was to understand how the governance structure of innovation habitats may contribute to the development of innovation in resident companies. From the proposed framework, the critical factors were identified in successful governance structure that impacts the development of innovation in resident companies, investigated from the cases of INOVAPARQ and CELTA.

Thus, it was found that the governance actions were represented by: relationship promoted by habitats with different stakeholders; training of national or international networks with habitats and prestigious international educational institutions; and encouragement of practical innovation from specific notices. These actions effectively contributed to the development of innovation from: exchange of experiences in inter-company; strategic use by resident companies of information generated by evaluations of managers of habitats; and credibility of the habitat used as a recognition factor of the companies in the market.

In addition, actions were found of resident companies regarding the constant search for new investors; the creation of new technologies from the market needs monitoring; and the use of strategic information of evaluations and supervision carried out by habitats. These actions are resulted from the relationship built by the managers of habitats with its resident companies, and represent a competitive advantage of the system generated by habitats in the innovative development and economic sustainability. Finally, stimulating innovation it is also found in resident companies through the exchange of experiences and information with different stakeholders, which in addition to habitat credibility, result in the recognition of those companies by the market and the promotion of important trade agreements and internationalization processes countries of interest.

We also expect that the promotion and articulation of actors present in innovation habitats represent an applied contribution of the study, identifying facilitating elements so that the dialogue between habitat managers and companies can be enhanced.

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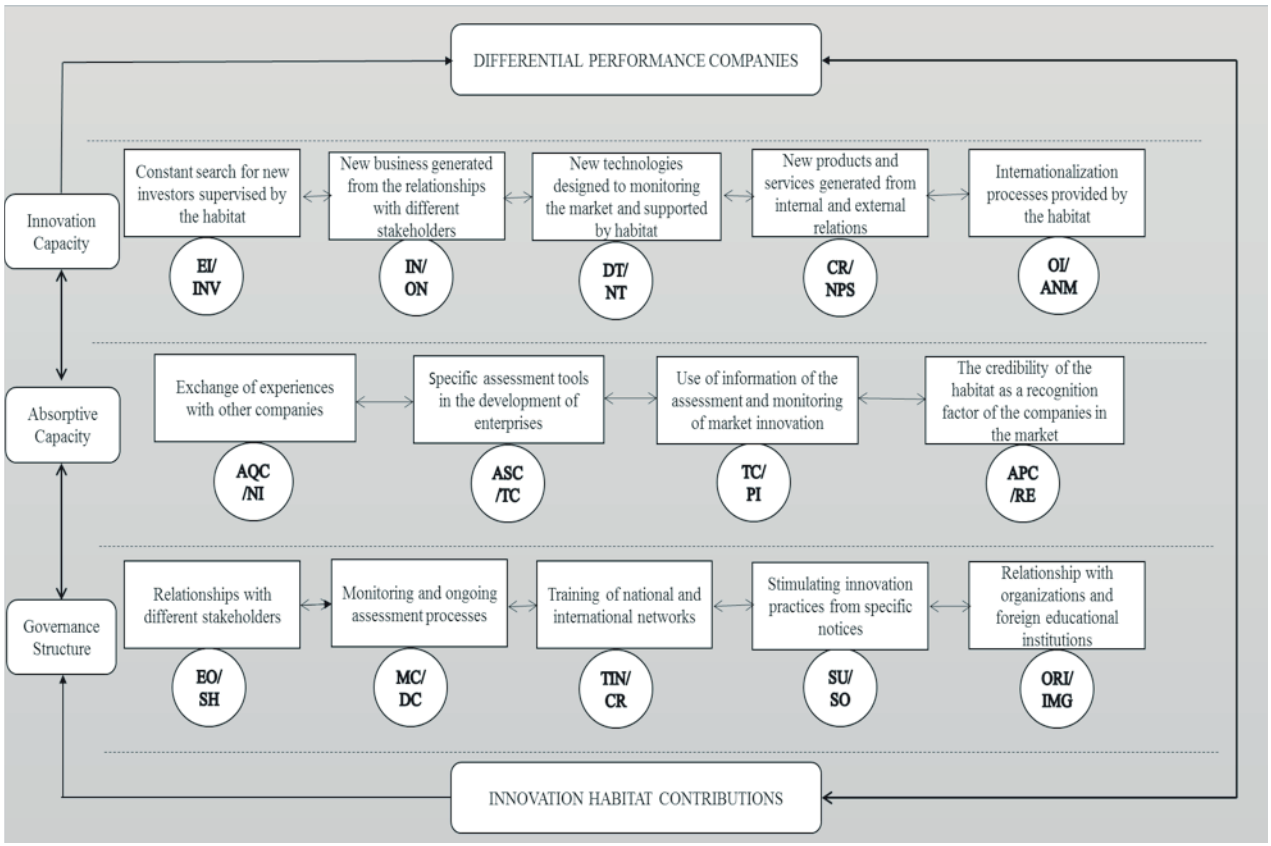
Appendix 1

Figure 4. Framework for the development of capacities in innovation habitats



Legend: Governance Structure: Category: EO - Organizational Structure / Indicator: SH - Stakeholders. Category: MC - Growth Facility / Indicator: DC - Capacity building. Category: TIN - Technology, innovation and networking / Indicator: CR - Network Cooperation. Category: SU - Sustainability / Indicator: S - Social. Category: ORI - international relations Opportunities / Indicator: IMG - integration with global markets. Absorptive capacity: Category: AQC - Acquisition of knowledge / Indicator: NI - Internal Networking. Category: ASC - Assimilation of knowledge / Indicator: TC - Training and capacity building. Category: TC - Knowledge transfer / Indicator: PI - Innovation processes. Category: APC - Application of knowledge / Indicator: RE - Recognition. Innovation Capacity: Category: EI - Boosting Innovation / Indicator: INV - Investor. Category: IN - Innovativeness / Indicator: ON - Business opportunities. Category: DT - Technological development / Indicator: NT - New technologies. Category: CR - Creation / Indicator: NPS - New products and services. Category: HI - International Opportunities / Indicator: ANM - Access to new markets.

ISSN: 0718-2724. (http://jotmi.org)

R&D investment and the arrangement of innovation capabilities in Brazilian manufacturing firms

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Abstract: This paper aims at identifying the different arrangements of innovation capabilities for firms with different levels of R&D investment. The four innovation capabilities model (development, operations, management and transaction) by Zawislak et al., (2012) was crossed with the three level – low, medium and high – R&D intensity classification by Legler and Frietsch (2007). A multiple regression was applied on data from a survey of 1,331 Brazilian manufacturing firms, results clearly show different arrangements of innovation capabilities for each level of R&D investment. Operations capability does not generate innovation performance in any level. Development capability becomes increasingly relevant to performance, as R&D investment increases, on the other hand, management and transaction capabilities turn to be less prominent.

Keywords: Innovation; R&D Investments; Innovation Capabilities; Capabilities Arrangements

Submitted: August 30th, 2018 / Approved: November 13th, 2018

1. Introduction

Traditionally, innovation studies at the firm level follow two perspectives: innovation as the result of R&D investments and as the consequence of different innovation capabilities. However, although there is important research in each of these perspectives, studies that explicitly link them are scarce (see for example, Reichert et al., 2016; Rasiah et al., 2016; Chamsuk et al., 2017). The present paper goes exactly in the direction of better understanding the relation between R&D investment and innovation capabilities.

In the first perspective, investments in R&D are a traditional indicator of innovation, both at the firm and macroeconomic levels. Different authors (e.g., Mansfield, 1980; Griliches, 1986; Gonzalez & Gascon, 2004) have provided evidence pointing at the positive effects of R&D investment over the increase of productivity and innovation. Firm's R&D intensities are usually measured based on the percentage of revenue invested in these activities (OECD, 2003; Legler & Friestch, 2007).

Regarding the second perspective, the debate on how firms can build innovation capabilities goes back to the 1970's. In a broad sense, as stated by Richardson (1972), capabilities represent the firm's accumulation of knowledge, experience and skills, which will be responsible for the acquisition of competitive advantages. Later, Lall (1992), Bell and Pavitt (1993) trying to understand how product and process innovation emerge, proposed models for the technological capabilities of the firm. Recently, the concept of 'innovation capabilities' has been enlarged, it now goes beyond technological issues and considering organizational skills as important assets to build capabilities (Teece et al., 1997; Dosi, 2000). Recent innovation capabilities models (Guan & Ma, 2003; Yam et al., 2011; Zawislak et al., 2012) seek to explain how different types of capabilities can be arranged to generate innovation.

Despite the development of those two perspectives, some issues can be raised, for example: How can one connect R&D investments with innovation capabilities? What are the different arrangements of capabilities for different levels of R&D investment? Can a firm that invests little in R&D be innovative?

To answer these questions, the present study correlates Legler and Friestch's (2007) R&D intensity classification with Zawislak et al.'s (2012) innovation capabilities model. The paper uses a pre-existent database with a sample of 1,331 firms from different manufacturing sectors in Brazil to make a multiple linear regression. Three different optimal capability arrangements, one for each level of investment in R&D, were obtained.

The use of Brazilian firms is justified by the country's industrial characteristics. At the same time, Brazilian industry holds a wide repertoire of sectors, such as food, metallurgy, machinery and equipment, chemistry, etc. (Reichert et al., 2015), and presents a great diversity of levels of R&D investment between the companies (Furtado & Carvalho, 2005). This research is expected to help companies on formulating innovation strategies according to their R&D investment levels, as well as supporting the formulation of specific and appropriate public policy to foster innovation in firms at different levels of R&D investment.

After this introduction, the paper is structured in six more sections: section 2 presents a brief literature review on R&D investments. Section 3 addresses the concepts of innovation capabilities, presenting the capabilities model deployed. Section 4 explains the method, the multiple linear regression, and why it was chosen. Sections 5 and 6 bring the results and discussions, respectively. Finally, Section 7 presents the concluding remarks.

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ISSN: 0718-2724. (http://jotmi.org)

2. R&D Investments

Innovation studies have been mostly focused on the technological nature of the phenomenon. They usually try to understand how firms develop new products and processes. In this scenario, the amount of investment in R&D activities is the most used indicator, and by far the longest standing (Smith, 2005). One of the first studies that seek to understand how technological innovation occurs was conducted by Utterback and Abernathy (1975). It shows how firms go from innovating in products to innovating in processes, as their technological base matures. Later, Pavitt (1984) identified that firms with higher levels of R&D investment tend to innovate in products, while those with lower levels, tend to concentrate their activities in process innovation. While in-process innovation seeks to reduce production costs (Freeman & Perez, 1988), it is expected that high R&D investments lead firms to develop and introduce new products on the market (Freeman & Soete, 1997). Since product innovation is much easier to notice than process innovation, firms that invest little in R&D are usually classified as less innovative.

The percentage of revenue invested in R&D, or 'R&D investment', is often used to define the technological intensity of a given sector or firm (Godin, 2008). The Organization for Economic Cooperation and Development (OECD) (2003) developed a classification to categorize manufacturing sectors into four technological intensity levels. The parameter is the average percentage of revenue invested in R&D by firms belonging to each different sector. The levels are: Low technological intensity – up to 1% of the revenue invested in R&D; Medium-low technological intensity – more than 1% and up to 2.5% of the revenue invested in R&D; Medium-high technological intensity – more than 2.5% and up to 7% of the revenue invested in R&D; and High technological intensity – above 7% of the revenue invested in R&D.

Based on OECD's classification, Legler and Frietsch (2007) have built a similar, but simpler, classification. It divides the levels in three different technological intensities: low – less than 2.5% of the revenue invested in R&D; medium – from 2.5% to 7% of the revenue invested in R&D; and high technological intensity – more than 7% of the revenue invested in R&D.

The OECD's (2003) classification was used to identify innovation capabilities arrangements in firms of low technology industries by Reichert et al. (2016), and to analyze the innovation behavior of high technology and medium high technology industries by Villamizar et al., (2017). On the other hand, Legler and Frietsch's (2007) classification, for example, was applied by Kirner et al. (2009) to interpret the innovation behavior of firms that invest little in R&D.

The use of R&D investments as proxy for innovation has been, however, controversial. One of the problems with the industry-based classification is that it has been proposed and elaborated for the reality of developed countries – about 90% of the 35 OECD countries are developed (CIA, 2017). According to Furtado & Carvalho (2005), in developing countries, such as Brazil, it is common to find firms that would be classified as high technological due to their sector, however, by concentrating on operational plants, doing very little or no development at all, and with much of the technology coming from abroad they end up behaving as low-technological (Reichert & Zawislak, 2014). Those firms tend to follow headquarters' directives and focus their attention on improving production process, consequently, as aforementioned, they tend to hold lower levels of investment in R&D. The pharmaceutical industry in Brazil (Malerba & Mani, 2009) and India (Chittoor et al., 2008), as the electronics industry in China (Chittoor et al., 2008), are examples of this kind of phenomenon. Moreover, at the same time, some firms, belonging to low technological industries, such as food, rubber and metalworking, present higher levels of investment in R&D (Furtado & Carvalho, 2005).

The approach to innovation as a sole result of R&D investments has also been criticized because it minimizes the innovativeness of the firm. As a result, firms with low levels of investment in R&D end up being understood as non-innovators, which is not necessarily true. This approach does not perceive, due to the model's limitation, that innovation is more than traditional technology development in products and processes. Innovation also happens in organizational and marketing domains (Hirsch-Kreinsen, 2015, Reichert et al., 2016). The innovation capabilities approach, in turn, has a broader scope, analyzing the innovation phenomenon from a more complete perspective.

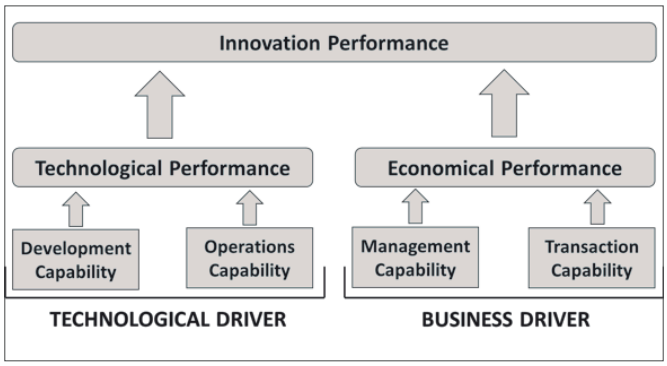
3. Innovation Capabilities

To be "capable" means to reach something that was intended, thus, the firm's capabilities fill the gap between the planned intention and the result achieved (Dosi, 2000). The term capability was firstly defined by Richardson (1972) as a set of experiences and knowledges accumulated over time by the firm. Later, Nelson and Winter (1982) stated that capabilities are connected to firms' ability to adapt its routines and skills according to the market and technological changes. Since those changes are unstoppable, capabilities must be dynamic to adapt the firm to those changes and allow for its survival (Teece et al., 1997). The result of this adaption process is innovation. Therefore, the most developed the dynamic capabilities are, the most innovative the firm will be and, as a consequence, the better will be its economic performance (Figueiredo, 2014).

From a Schumpeter' (1934) perspective, innovation capabilities should be understood by both a technological and a business driver. The technological driver encompasses innovation that arises from new products or new processes, in which the technological capability of Lall (1992) and Bell and Pavit (1993) stands out. The business driver deals with the importance of organizational change, the development of new strategies, and the adaptation to changing markets (Prahalad and Hamel, 1990). Teece et al., (1997) have a similar approach and highlights that the creation of value by a firm would not only be dependent on its technological assets, but also on organizational ones. Though, capabilities cannot be only built through investments in technology (Dosi, 2000). As a matter of fact, to transform any technology into an actual business, the company needs to create management routines and skills as well as to perceive and act upon market demands.

Different models of innovation capabilities follow the two drivers' approach as, for instance, Guan and Ma (2003) and Yam et al., (2011). In the same path, Zawislak et al., (2012) suggested an objective and synthetic model. Each of the capabilities in the model represents a form of innovation, divided into the two drivers. The technological driver includes development (new products) and operations (new processes) capabilities while the business driver, management (new forms of organization) and transaction capabilities (new forms of marketing). Innovation performance thus depends on both drivers and on the different arrangements of capabilities. The innovation capabilities model is illustrated in Figure 1.

Figure 1 – Innovation Capabilities Model



Source: Zawislak et al., (2012, 2013)

Development capability corresponds to the firm's routines and abilities to analyze the state of the art as well as to absorb, to adapt and to transform new technologies into new products (Bell & Pavitt, 1993). The goal is to reach higher or new levels of technical and economic efficiency (Zawislak et al., 2012). Dutrénit (2000) states that this capability is related to the use that the firm has of its knowledge. It is the result of the learning processes by which the firm internalizes new knowledge to make technological change and, consequently, to develop new products (Lall, 1992).

Operations capability is related to the firm's routines and skills in organizing, planning, scheduling, preparing, executing and controlling its production (Reichert et al., 2015). According to Zawislak et al., (2012), since the development capability is responsible for creating new products, the operations capability is responsible for manufacturing them on a commercial scale. This capability is determined by the firm's knowledge of its production process. It results in new processes and new forms of manufacturing organization, aiming at generating competitive advantage generation through costs reductions, time to market decrease, and the improvement of product quality and of operation's flexibility (Hayes & Pisano, 1994; Reichert et al., 2011).

Management capability is concerned with routines and skills for the best allocation of technological, material, financial and human resources (Lazonick, 1992). Unlike development and operations capabilities, it is not determined by applied knowledge (technology), but rather by a broader set of organizational skills (Langlois, 2003). It results in the implementation and use of new business models and new management tools, focusing on the efficiency of supporting processes to the firm's main activities (Barnard, 1966; Chandler, 1977; Teece et al., 1997; Zawislak et al., 2012, 2013).

Finally, *transaction capability* corresponds to ability and routines to minimize the transaction costs and deal with the marketing activities. For Zawislak et al., (2012), once a technological solution has been developed, produced and managed, the firm must turn its efforts to its commercialization. This capability is characterized by research and relationship with the market, search of suppliers and customers, brand development, service and negotiation, product sales, logistics process (supplies and distribution) and after-sales (Reichert et al., 2015). Its results are perceived through new forms of commercialization, new sales channels, new market niches, new brands, new services (Hirsch-Kreinsen, 2008), or new suppliers and supply processes, with lower costs than current ones (Zawislak et al., 2012, 2013).

After explaining the capabilities model, it remains to be known how those capabilities can be arranged to generate innovation in firms with different levels of investment in R&D. For that, the next session presents the research method.

4. Research Method

The present study made use of a database from NITEC (Innovation Research Centre), a research group linked to UFRGS (Federal University of Rio Grande do Sul). The database is the result of a survey conducted in 2014, which aimed to analyze the innovativeness of Brazilian manufacturing firms. The survey resulted in 1,331 valid questionnaires. The questions asked are presented in a five-point Likert scale, where 1 corresponds to totally disagree, and 5 to strongly agree. Questions were divided into four blocks of firms´ capabilities (7 items related to development capability, 9 to operations capability, 7 to management capability, and 6 to transaction capability) and a block of innovation performance (3 items), totaling 32 items. In addition to these items, there are general questions about the company, in which the percentage of revenue invested in R&D is asked.

In order to meet the paper's objectives, the following statistical techniques were used: mean, standard deviation, factorial analysis and multiple regression. We used Microsoft Excel 2013 and SPSS (*Statistical Package for Social Sciences*) version 18.

Firstly, sample's firms were grouped according to their respective R&D investment level. The present research used Legler and Frietsch's approach (2007) at the firm level due it better compatibility with the sample characteristics – there are large differences between the percentages of revenue invested in R&D among firms that belong to the same industry, which would distort the data at the sector level. According to Kirner et al. (2009) the main problem with a sectoral analyzes is that it does not take into account differences at the firm level. In order to clean the database, non-respondents (59 in total) and firms reporting R&D investments above three standard deviations of the mean were eliminated. The mean R&D investment level of the whole sample is 4.05%, and the standard deviation is 6.50%. Firms that

responded to invest 23.5% or more of their revenue in R&D were eliminated (14 in total). Such high values are considered unrealistic because, for example, the company that invests the most in R&D worldwide puts 17% of its revenue in those activities (Casey & Hacket, 2014). The final sample consisted of 1,258 firms, corresponding to 94.5% of the total. Table 1 illustrates.

Table 1 – Dataset

R&D investment level	Rate of the revenue invested on R&D	Companies	Rate of Total of companies
Low	From 0.00% to 2.50%	676	50.79%
Medium	Higher than 2.50% to 7.00%	366	27.50%
High	Above 7.00%	216	16.23 %
Number of Companies considered in the Analysis		**1.258**	**94.52%**
No answer	-	59	4.43%
Outliers	> 3 SD away from sample's average	14	1.05%
Total number of excluded		**73**	**5.48%**
Total number of companies		1.331	100%

Factor analysis was used to scrutinize the sample. This technique defines factors (constructs), and it also determines which items of each factor will or will not be included in the analysis according to their relative relevance to that particular factor (Green & Salkin, 2014). As factors are composed by sets of items, factor analyzes can be understood as a simplifying data technique (Hair et al., 2009). The type of factor analysis used was the PCA (Principal Component Analysis), with orthogonal rotation Varimax, which, according to Hair et al., (2009), facilitates the results' interpretation.

The 32 surveys items should generate different factors: one for each innovation capability, plus one for innovation performance. However, the first round of PCA presented six different factors. In this analysis, nine items had factorial loads lower than .5, which are considered unsatisfactory (Hair et al., 2009), and those nine items were excluded. The remaining 23 items were used in a second PCA analysis in which all factor loads where higher than .5 and that obtained the five factors predicted by the theory. Table 2 illustrates the survey items that were considered in the final analysis.

Table 2 – Remaining items and factors

Capability	Question	Description
Development	D1	Design its own products
	D2	Monitors the latest technological trends in the sector
	D3	Adapts the technology in use to its own needs
	D5	Prototypes its own products
	D6	Uses formal project management methods (Stage-Gate, PMBOK, innovational funnel, etc.)
	D7	Launches its own products
Operations	O5	Carries out the productive process as programmed
	O6	Establishes a productive routine that does not generate rework
	O7	Delivers the product promptly
	O8	Manages to expand the installed capacity whenever necessary
	O9	Manages to ensure the process does not lead to products being returned
Management	M1	Formally defines its strategic objectives annually
	M2	Includes social and environmental responsibilities on its strategic agenda
	M5	Updates its management tools and techniques
	M6	Maintains the personnel adequately trained for the company functions
	M7	Uses modern financial management practices
Transaction	T3	Imposes its negotiating terms on its suppliers
	T4	Imposes its prices on the market
	T5	Imposes its negotiating terms on customers
	T6	Uses formal criteria to select its suppliers
Innovation Performance	IP1	The net profit has grown continuously over the last 3 years
	IP2	The company´s market share has continuously grown over the last 3 years
	IP3	The company´s revenue has continuously grown over the last 3 years

The KMO (Kayser-Meyer-Olkin) test was applied to check the efficiency of the factor analysis: the result of .893 indicates that the PCA that was applied produced internally different and reliable factors (Kaiser, 1974; Field, 2009). In addition, the Barlett test results was bellow .001, also indicating the adequacy of the factor analysis (Hair et al., 2009). The total variation explained by the four factors related to innovation capability is 61.3%.

After the PCA, the multiple regression analysis was conducted. This analysis is indicated when the aim is to find the relationship between one dependent variable and more than one independent variables (Hair et al., 2009). In the present study, each of the four innovation capabilities represents an independent variable, while innovation performance is the dependent one. The objective is to find a equation whose coefficients (ß's) demonstrate the importance of each capability to performance, in a similar fashion to what was proposed by Alves et al., (2017) in Equation 1.

$$IP = ß_0 + ß_1DC + ß_2OC + ß_3MC + ß_4TC \quad \textit{Equation 1}$$

The innovation performance (IP) is a function of ß0 , a constant that represents the minimum legal, technological and economic requirements for the existence of any firm in a given sector, plus the ß of each capability (DC for development, OC for operations, MC for management and TC for transaction). The ß of the capabilities determine the importance of each one for the innovation performance, thus defining the capabilities arrangement necessary for the firm's competitiveness. An equation was identified for each level of R&D investment – low, medium and high, as the next session presents.

5. Results

For each level of investment in R&D, a table with the non-standard coefficients (B and the standard error) is presented, as the coefficient (ß), and the value of the test t – determining the significance of the capabilities. Values above 0.001 were considered non-significant (Hair et al., 2009). When talking about the coefficients, the higher are their values, the greater is the importance of capability for the innovation performance. At the same time, for each of the equations, a value of R^2 was also obtained. This value indicates how much the result of the dependent variable is explained by the independent variables. According to Hair et al., (2009), the higher the R^2, the higher the level of explanation of the independent variables over the dependent one.

With respect to R^2 values that were found, it should be pointed out that the innovation capabilities model only analyzes the firm, and considers that all external factors (for example, the influence of the legal environment, sector specificities, and more general macroeconomics issues) impact on firms´ innovation performance at the same time, in a more or less similar way. Thus, it is suggested that the environment corresponds approximately to three-quarters of factors influencing firms, while the remaining 25% of factors stay under the control of organizations. Because of that, the R^2 values were expected to be under the limit of .25.

Innovation capabilities arrangement for firms with low investment in R&D

For low R&D investment firms, the R^2 is .232, representing a high level of explanation by the applied capabilities model. Analyzing the coefficients and the significance from each of the capabilities, the most relevant ones for innovation are: management (.232), transaction (.222) and development (.165) respectively. The operations capability is considered not significant for this group.

Table 3 – Results for firms with low investment in R&D.

Capability	B	Standard Error	Coefficients (⊠)	T	Sig.
Constant	-.079	.041		-1.951	.052
Development	.165	.045	.165	3.692	.000
Operations	.019	.045	.019	.423	.672
Management	.246	.045	.232	5.473	.000
Transaction	.220	.040	.222	5.550	.000

n = 676

Therefore, for companies that do not invest, or invest a very small part of their revenue in R&D activities, innovation can be achieved through new management models that reduce administrative costs and create organizational efficiency. In these cases, innovation also can be obtained by new forms of transaction with the market, such as new ways of product selling, or new logistics and distribution techniques, which provide lower transactional costs, as the reach of new clients and new suppliers.

Likewise, these firms should focus their innovation efforts on product development activities, although they are not as necessary. New product development activities should involve the absorption of technologies from their suppliers, especially from machinery and raw materials ones, which will allow them to increase the quality of their products (Hirsch-Kreinsen, 2008, 2015). Thus, the innovation strategy of low R&D firms must be focused, firstly, on the cost reduction of managerial and transactional process. On a secondary level, these firms must establish routines and skills for improve products quality (Reichert et al., 2016). Equation 2 illustrates the capabilities arrangement that brings innovation for this group of firms (considering only the significant capabilities).

$$IP = -0.079 + 0{,}232*MC + 0{,}222*TC + 0{,}165*DC + e \quad \textit{Equation 2}$$

Innovation capabilities arrangement for firms with medium investment in R&D

In this level of investment, the R^2 is .194, still with a high explanation level. The coefficients, associated with the significance of the constructs, indicates the relevance of the development capability (.300) and of the management one (.188). Operations and transaction capabilities were not significant.

The higher importance of the development capability is easy to observe, as well as the smaller relevance of the management capability when compared to low R&D investment firms. Thus, for medium R&D investment firms, innovation comes mainly from the development of new products, supported by new managerial models.

Table 4 – Results for firms with medium investment in R&D

Capability	B	Standard Error	Coefficients (⌧)	T	Sig.
Constant	.120	.044		2.698	.007
Development	.274	.054	.300	5.108	.000
Operations	.009	.053	.010	.170	.865
Management	.178	.052	.188	3.385	.001
Transaction	.077	.055	.078	1.404	.161

n = 366

The innovation strategy in this group is based on the adaption of technological novelties, that emerge from firms with higher investments levels in R&D – those companies do not just simply copy new products, they do try to improve upon previously existent products, a feature that demands more elaborated technological routines and skills (Freeman & Soete, 1997). As their new products do not allow a temporary market monopoly, these firms also need to innovate in the management techniques to reduce administrative costs, and improve profit margins. Equation 3 summarizes the arrangement required for medium R&D investment firms (presenting only significant innovation capabilities).

$$IP = 0{,}120 + 0{,}300*CD + 0{,}188*CG + e \qquad \text{Equation 3}$$

Innovation capabilities arrangement for firms with high investment in R&D

The R^2 for high R&D firms is .177, maintaining the elevated explanation power of the capabilities model. For this group, the only significant capability is the development one, presenting a coefficient at .316. The other three capabilities: management, transaction and operations, are not significant.

The development capability importance increased when compared to the medium R&D firms. Since innovation can only be reached by the development capability, these firms should focus all their innovation efforts on the development of new products. The elevated amounts of capital invested in R&D activities involves severe risks, and because of it, these firms must generate radical innovations, with brand new products.

Finally, Table 5 shows the results for firms with high investments in R&D.

Table 5 – Results for firms with high investment in R&D

Capability	B	Standard Error	Coefficients (⌧)	T	Sig.
Constant	0,075	0,067		1,120	0,264
Development	0,352	0,086	0,316	4,081	0,000
Operations	0,078	0,070	0,083	1,114	0,266
Management	0,078	0,068	0,087	1,158	0,248
Transaction	0,027	0,070	0,026	0,380	0,704

n = 216

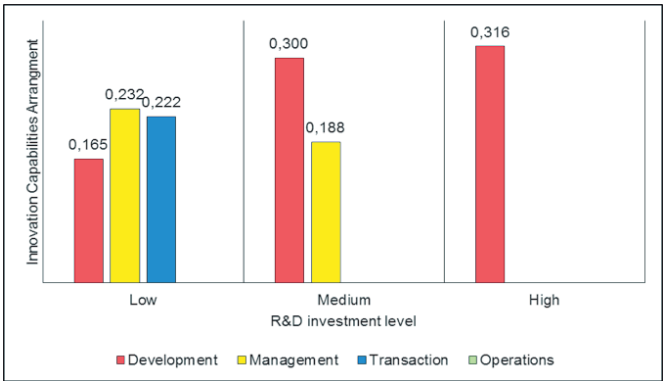
Commonly this kind of innovation fills demand gaps, establishing new patterns of productivity and consumption in the market (Freeman & Perez, 1988). With that, the firms could obtain Schumpeterian profits for determined period, compensating the risks involved on their R&D activities. The results demonstrate the overwhelming importance of routines and skills for transform new technologies in new products, overlapping the transactional, managerial and operational ones, in such way that they even do not even matter for innovation performance, in this group. Equation 4 illustrates the capabilities arrangement for the high R&D firms (considering only the significant ones).

$$IP = 0{,}075 + 0{,}316\ DC + e \qquad \textit{Equation 4}$$

6. Discussion

Figure 1 summarizes the results and presents the capabilities arrangements obtained for each of the three levels of R&D investment, demonstrated by the coefficients obtained for capabilities on each R&D investment level.

Figure 2 – R&D Investment Levels versus Innovation Capabilities Arrangements



The first aspect observed is the operations capability irrelevance on all levels of investment in R&D. Alves et al., (2017) have already demonstrated, in a study carried out with the same database and with the innovation capabilities model, that the operations capability is not able to generate competitive advantages and differentiation between firms. It is

thus considered an 'ordinary capability', that is not really able to generate innovation in this context. The operations capability is, of course, relevant for the firm existence, but does not have a significant influence on the innovation performance. Nevertheless, this capability is the most prominent in the sample's firms (Reichert et al., 2015). It is understood that this phenomenon occurs because innovation efforts related to operations capability are standardized among the sample: all firms use similar equipment, and all of them apply very similar techniques for the process organization, planning, scheduling setup, execution and control. Thus, when a capability cannot generate differentiation between peers, it hardly provides innovation (Nelson & Winter, 1982).

Secondly, as R&D investments increase, there is a gradual lost of relevance of business driver innovation capabilities (management and transaction). At the same time, development capability becomes more important. That is, as companies invest in R&D activities, they increase their routines and skills to monitor, absorb, adapt and transform technologies in new products, giving less relevance to those capabilities attached to organizational innovation.

Somehow, it is as if the business driver capabilities end up compensating the little elaborated development capability, which is a consequence of the low levels of revenue invested in R&D. This corroborates to the thesis of organizational innovation importance for firms that do not invest, or invest low values in R&D (Christensen, 1994, Kirner et al., 2009, Hirsch-Kreinsen, 2015, Reichert et al., 2016).

Furthermore, for firms with low R&D investment the only ordinary capability, i.e. the only one which was irrelevant for the innovation performance, was the operations one. For firms with medium investment levels, the transaction capability also became irrelevant (beyond operations capability), and finally, for high investors, all others became ordinary, except for the development capability.

Regarding the average of firm's capabilities by level of investment in R&D (See Table 6), it can be observed that capabilities naturally increase in accordance with the increase of R&D investment levels. Table 6 illustrates this situation, analyzing survey items averages related to the capabilities.

Table 6 – Average of firms capabilities by level of investment in R&D

R&D Investment Level	Capabilities Averages[a]			
	Development	Operations	Management	Transaction
Low	3,46	3,95	3,72	3,38
Medium	3,72	3,93	3,99	3,61
High	4,15	4,19	4,10	3,84

[a] Capability are presented in a five-point Likert scale (1: totally disagree and 5: strongly agree)

The data shows that, the more elaborated and standardized the firm´s capabilities become (when compared to their competitors), the less able they are to have some impact on innovation performance (IP). In those cases, having very high levels of all other capabilities (except for the development one) becomes irrelevant when it comes to differentiate the firms from its competitors in the market. That replicates the phenomenon observed by Alves et al., (2017) over the operations capability. Although this idea finds support in the data, more research on this topic is needed, adding specificities and comprehensiveness. If results are corroborated than it would be safe to state categorically that this phenomenon is something repetitive and constant.

7. Concluding Remarks

This article has identified innovation capabilities arrangements for firms at different levels of R&D investment. The different arrangements signalize which forms of innovation can differentiate companies in their respective markets, and thus achieve a satisfactory economic performance. The levels of investment in R&D were defined using the Legler and Frietsch (2007) model, which establishes three levels – low, medium and high. To identify the capabilities arrangements, the multiple linear regression method was applied, based on Zawislak et al., (2012) four firm´s innovation capabilities model – development, operations, management and transaction.

The results demonstrated that, at each level of investment in R&D, any firm demands a specific capabilities' arrangement for reach innovation. Firms with low R&D investment level should innovate through management, transaction and development capabilities. They must focus their innovation efforts on reducing managerial and transactional processes costs, as well as seeking for absorb new technologies from their suppliers, aiming to improve the quality of their products.

Meanwhile, firms with medium R&D investment levels must innovate through development and management capabilities. This kind of firm doesn´t innovate through the transaction capability (minimize transaction cost and marketing activities), but rather from the improvement of products developed. This strategy does not allow them to obtain Schumpeterian extraordinary profits, so the optimization of managerial processes is necessary to reduce costs, and increase the margins.

Finally, high R&D investment firms innovate only by development capability. This level consist on firms that must be highly focused on the elaboration of new products, establishing radical innovations, as well new standards of productivity and consumption in the markets.

Operations capability has not demonstrated relevance for firm´s innovation performance at any level of R&D investment. It´s understood that since mostly firms in the sample possess standardized

operational routines and skills, this capability is not able to differentiate the firm from their competitors, and thus fails to generate innovation. It´s also observed that as the level of R&D investment increases, the less relevant become the business driver capabilities (management and transaction), and more relevant become the development capability. It is inferred, therefore, that business driver capabilities end up compensating the lack of well elaborated development routines and skills – likewise, the development capability prominence dispenses the need of management and transaction capabilities for innovation.

The managerial implications of these results are relevant with regard to the innovation strategy to be adopted. Firms do not necessarily need to invest high amounts of capital on R&D activities to innovate. Even firms that adopt a more conservative stance, not taking risks with investments in technology, can innovate through new models of management and of transaction with the market. But if the firm really wants to develop new products, revolutionize its market, and reap the gains from it, it needs to invest high R&D values.

Regarding the policy implications, it should be emphasized that governmental actions must take into account the suggestions presented in this research. In particular, policymakers should be careful while developing policies to foster expenditures on technological innovation. The paper shows that not all companies will innovate in the same way, thus a policy that fosters one specific kind of innovation can be detrimental to the overall innovation performance (and consequently to financial performance) of firms. Policymakers should have in mind that the set of companies under their umbrella is very broad and perhaps R&D investment is not so relevant to innovation in that particular environment.

Two future researches can be developed based on this paper's results. The first would be the conduction of this analysis with data coming from different parts of the world, either emerging, developed or developing countries. It would be interesting to understand the distinct capabilities arrangements for different R&D levels in diverse macro-economic realities and economic sectors (e.g. agribusiness and services). The second one relates to a deeper analysis over an important observation: the lost of capabilities relevance for innovation. The higher the level of investment in R&D, the more elaborate are the firms' capabilities, and more capabilities became ordinary – only one capability is ordinary on low R&D level, but two became ordinary on medium R&D level, and three on high R&D level. Further research could be carried out in this sense, contributing to better understanding of the innovation capabilities importance.

Acknowledgements

The present study received financial support from the Brazilian National Council for Scientific and Technological Development (CNPq) and from the State of Rio Grande do Sul Research Foundation (FAPERGS).

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Modelo predictivo de la intención emprendedora universitaria en Latinoamérica

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Resumen: El presente estudio explora la intención emprendedora y los factores que inciden en la misma, para estudiantes universitarios de seis países latinoamericanos provenientes de empresas familiares. Se trabaja con un modelo de regresión ordinal logística con el fin de probar las hipótesis del modelo teórico de investigación y generar una ecuación matemática que permita cuantificar y predecir la intención emprendedora de un estudiante universitario utilizando como variables explicativas: el tipo de relación con la empresa familiar, la vinculación con la innovación, la motivación para emprender, la actitud emprendedora (entendida como búsqueda de placer y poder) y el PBI de cada país. La investigación fue realizada en el marco RLIE (Red Latinoamericana de Innovación y Emprendimiento) en estudiantes que por lo menos tenían un curso de emprendedurismo en su carrera del área empresarial o ingeniería y provenían de nueve universidades diferentes de América Latina.

Palabras clave: Empresa familiar; Intención emprendedora; Emprendimiento universitario.

Abstract: Predictive Model of University Entrepreneurial Intention in Latin America
The present study explores the entrepreneurial intention and the factors that affect in college students from six Latin American countries coming from family businesses. A logistic ordinal regression model is used in order to test the hypothesis from the theorical model of investigation, and to generate a mathematical equation that allows to quantify and predict the entrepreneurial intention in college students using as explanatory variables: the type of relationship with the family business, the link with innovation, the motivation to undertake, the entrepreneurial attitude (understood as a search for leisure and power) and the GDP of each country The investigation was made in the frame of CLADEA´S RLIE (Red Latinoamericana de Innovación y Emprendimiento de CLADEA) in students that had at least one entrepreneurship course in their career in the area of business or engineering and came from one of nine different Latin American universities.

Keywords: Family Business; Entrepreneurial intention; University entrepreneurship

Submitted: Julyt 16th, 2018 / Approved: November 6th, 2018

Introducción

El estudio busca identificar factores que ayudan a predecir la intención emprendedora del estudiante universitario en América Latina. Los emprendedores tiene un rol fundamental en la creación de bienestar en la sociedad, impactando de forma positiva en el desarrollo de las economías de los países, por lo que es importante el éxito en el aprendizaje del espíritu empresarial innovador (Fayolle, 2013; Kakouris y Georgiadis, 2016).

Este trabajo fue posible gracias a la colaboración de universidades participantes de la Red Latinoamericana de Innovación y Emprendimiento (RLIE) que permitió recabar 3.341 datos de estudiantes de México, Puerto Rico, Ecuador, Colombia, Brasil, Uruguay y Chile, provenientes de nueve universidades que buscan promover el emprendimiento entre sus estudiantes. Para esta investigación se seleccionó una submuestra de 771 universitarios que provenían de empresas familiares y ocho universidades.

Para explicar la intención emprendedora, los factores analizados fueron: el tipo de relación con la empresa familiar, la vinculación con la innovación, la motivación para emprender, y la actitud emprendedora, entendida como búsqueda de placer y poder (Bonomo, Krauss, & Volfovicz, 2017). Por otra parte, las variables de control utilizadas fueron el PBI de los países y una división Norte-Sur que se obtuvo en una investigación anterior realizada por este equipo y publicada en CLADEA 2016 (Krauss, y otros, 2016).

El aporte realizado es relevante ya que se genera una ecuación matemática predictora de la intención emprendedora de un estudiante universitario, aplicando un modelo de regresión ordinal logística a nivel latinoamericano que puede ser utilizado por académicos que quieran profundizar aspectos en la investigación, por las empresas familiares para que puedan contribuir a detectar el interés del hijo/a en dirigir la empresa a futuro y apoyarlo en la formación tanto interna como a nivel de la elección de su carrera, y para stakeholders a los que les preocupe el desarrollo de la actividad emprendedora y el negocio familiar.

El presente documento se inicia con una revisión de literatura en temas relacionados con el emprendimiento. A continuación se describe la metodología utilizada para desarrollar la investigación así como los resultados obtenidos. Por último se desarrollan comentarios finales, limitaciones del estudio y futuras investigaciones.

La teoría del comportamiento planificado futuro (*TPB- Theory of Planned Behavior*) de Ajzen (1991) sirve de marco de referencia para investigaciones ya que la intención es considerada un indicador del grado de esfuerzo individual o grupal y de la disposición a ejecutar un comportamiento cuando sea el momento y la oportunidad

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adecuada. Los tres factores que explican el comportamiento son: 1) la evaluación personal, 2) la presión social y 3) la facilidad o dificultad percibida para su realización.

El cuestionario en el que se basó la investigación utilizó en TBP ya que es una herramienta con un fuerte poder para llegar a pronosticar la intención emprendedora de los estudiantes universitarios (Krueger, Reilly y Carsrud, 2000; Liñán y Chen, 2009; Maes, Leroy, y Sels, 2014). A pesar de esto, se han encontrado evidencias que el hecho de que los estudiantes indiquen que tienen intención de emprender no implica que luego lo lleven a cabo (Shirokova, Osiyevskyy, y Bogatyreva, 2016).

Por otra parte, se ha analizado el impacto positivo en la intención emprendedora de los estudiantes luego de realizar cursos de emprendimiento a nivel universitario, dónde desarrollan la creatividad, la innovación en las ideas y la generación de modelos de negocios, mostrando luego un mayor deseo de iniciar su propio emprendimiento (Bergmann, Hundt, y Sternberg, 2016).

Uniendo la TBP con estudios universitarios, se ha encontrado que el contexto familiar y de amigos tiene una mayor influencia en la intención de emprender que el entorno de la universidad (Yurtkoru, Kuscu, y Doganay, 2014). Por lo que el desarrollo del espíritu emprendedor tiene una estrecha relación con proceder de una familia empresarial, siendo la motivación una estrategia clave y un antecedente importantes de la intención emprendedora (GUESSS, 2013).

A su vez, los factores individuales como rasgos de personalidad, actitudes y el contexto institucional condicionan las intenciones emprendedoras de los estudiantes entre 18 y 34 años (Gubik y Farkas, 2016). El GEM (Global Entrepreneurship Monitor) a nivel mundial ha encontrado que los jóvenes tienen 1,6 veces mayor intención emprendedora que los adultos (Schott, Kew, y Cheraghi, 2015).

Dentro de los factores analizados en esta investigación se encuentra la relación de los estudiantes con la empresa familiar, entendiendo la misma como un negocio gobernado y/o manejado con la intención de formar y seguir la visión de la empresa por una coalición dominante, controlada por los miembros de una misma familia o de una pequeña cantidad de familias de una manera que es potencialmente sostenible a través de las generaciones (Navarro de Granadillo, 2008).

La visión compartida por los miembros de la empresa familiar tiene un gran efecto en el grado de involucramiento de los jóvenes con su trabajo como miembros del equipo (Miller S. P., 2014) . Por otra parte, considera que solamente es positivo el efecto si la experiencia del modelo parental es exitosa (Criaco, Sieger, Wennberg, Chirico, y Minola, 2017).

Las empresas familiares tienen un rol dominante en el desarrollo económico de muchos países, pero presentan dificultades a la hora de la sucesión familiar, impactando en el futuro del negocio (Luan, Chen, Huang, y Wang, 2017). Brännback, Carsrud y Schulte (2008) identifican, en su estudio del proceso de sucesión de la empresa familiar, la importancia de la percepción del lugar que ocupa como miembro de la familia, así como lo esencial de la creación de conocimiento y el compartirlo. A su vez, el aspecto que más influye en el deseo de dirigir la empresa familiar es haber elegido una carrera profesional relacionada con la actividad principal de la empresa (González y Herrera, 2017).

Otro factor de la investigación es cuantificar cómo la innovación que realizan las empresas impacta en la motivación que tienen los estudiantes por trabajar en ellas. Para ello es fundamental la postura que existe en la empresa familiar respecto a la innovación. La misma se potencia cuando muchos de los miembros están a favor, o es perjudicada por una mala relación familiar. La elección de un sucesor competente y no elegido simplemente por favoritismo del fundador, augura un éxito en el esfuerzo innovador (Rondi, De Massis, y Kotlar, 2017).

La familia debe estar activamente involucrada en el management para mejorar el ratio de conversión de aplicación de la innovación. Solamente contar con personal capacitado y experiente no alcanza si no hay una gerencia profesional tanto externa como familiar (Diéguez-Soto, Garrido-Moreno, y Manzaneque, 2018). La innovación está muy influencia por la interdependencia entre diferentes tipos de contexto: público, político, organizacional, social, sectorial, financiero, el financiamiento, y políticas públicas (Autio, Kenney, Mustar, Siegel, y Wright, 2014).

En el cuestionario utilizado, los factores de motivación y actitud personal se analizan en conjunto. En la teoría del TBP, el control interno percibido tiene que ver con la autoeficacia, autodirección y el componmente de contexto social en el control percibido externo. La autoeficacia puede ser determinada preguntando las percepciones individuales de ser capaces de realizar un determinado comportamiento Por otra parte, el control gira en cómo alguien se siente en el dominio de la performance (o no performance) del comportamiento. Ambos conceptos, autoeficacia y control, están interrelacionados y se usan como el constructo de control percibido interno en la identidad social del emprendedor (Ajzen I. , 1991; Ajzen I. , 2002; Brändle, Berger y Kuckertz, 2018).

McClelland (1973) recalca el impacto de la necesidad de logro (n-logro) y la necesidad de poder (n-poder) en los emprendedores. El desarrollo de las competencias profesionales es importante para la educación de las futuras generaciones y es esperable que contribuya positivamente en los estudiantes en temas de seguridad en sí mismos, competencias y características emprendedoras (Karabulut y Dogan, 2018).

Si bien nuestro análisis de componentes principales no coincidió en todos los aspectos de la teoría, en este estudio se consideraron varios factores de TBP, como la relación que tienen los estudiantes con la empresa familiar, la innovación realizada en la misma, su motivación para emprender y su actitud incorporando además un análisis de cluster considerando las universidades de los países latinoamericanos que participaron de la investigación.

Metodología

Muestra

Se estudió una muestra constituida por 771 estudiantes de 8 Universidades latinoamericanas pertenecientes a la RLIE, de 6 países (EICO Universidad de Valparaíso, Chile; UCU, Universidad Católica del Uruguay, Uruguay; IFRS Instituto Federal de Educação Ciência e Tecnologia do Rio Grande do Sul, Brasil; ESPOL Escuela Superior Politécnica del Litoral, Ecuador; UCSG Universidad Católica Santiago de Guayaquil, Ecuador; TEC Tecnológico de Monterrey en Puebla; México; UNL Universidad Nueva León, México; UMNG Universidad Militar Nueva Granada, Colombia; UIPR Universidad Interamericana de Puerto Rico Recinto Bayamon, Puerto Rico). En el análisis se descartan los datos de Puerto Rico por presentar pocos casos de empresas familiares

Análisis Estadístico

El análisis estadístico se ejecutó en dos etapas. En una primera fase se procedió a realizar un Análisis de Componentes Principales (ACP). En la segunda fase, los factores extraídos mediante ACP fueron utilizados como variables explicativas (independientes) en el desarrollo e implementación de un modelo de regresión logística ordenada que busca: i) probar las hipótesis del modelo teórico de investigación desarrollado en la fase 1. ii) identificar los factores que significativamente contribuyen al emprendedurismo. iii) llegar a predecir la intención emprendedora (variable explicada o dependiente) de los estudiantes universitarios en el conjunto de universidades latinoamericanas que conforman el universo de estudio. Para el análisis estadistico se utilizó el paquete SPSS V.20

Resultados y Discusión

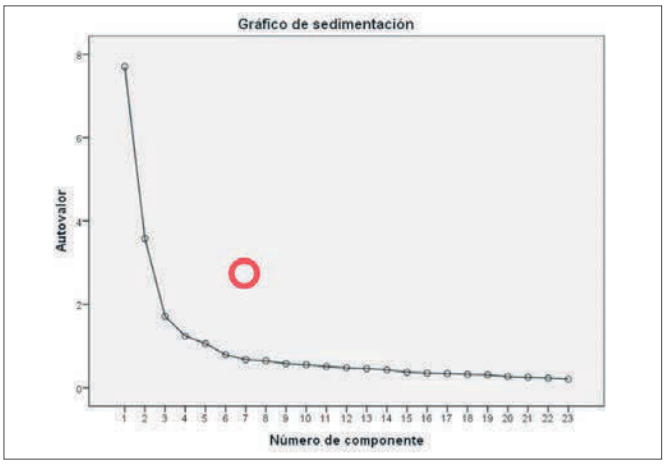
Se realizó un ACP con una una rotación ortogonal de tipo Varimax. Se comprueba una muy buena adecuación de los datos al modelo ACP (estadístico KMO Kaiser-Meyer-Olkin = 0,923). Se comprueba además la idoneidad del ACP mediante la prueba de esfericidad de Bartlett (Chi-cuadrado= 9658,739; gl = 253; valor-p=,0000). No se detectaron problemas en la matriz de correlaciones ni en la matriz anti-imagen en este estudio.

La Tabla 1 permite decidir el número final de componentes, y se opta por seleccionar los primeros 4 componentes principales que explican aproximadamente el 62% de la varianza total.

Tabla 1 Varianza total explicada

Componente	Autovalores iniciales		
	Total	% de varianza	% acumulado
1	**7,706**	**33,505**	**33,505**
2	**3,579**	**15,559**	**49,065**
3	**1,711**	**7,437**	**56,502**
4	**1,238**	**5,384**	**61,886**
5	1,058	4,602	66,487

Figura 1 Gráfico de sedimentación



En la Figura 1 se presenta el gráfico de sedimentación de las componentes, el que sugiere la selección de los primeros cuatro factores. Para conseguir una interpretación clara de los factores extraídos se procedió a la rotación factorial Varimax. A continuación, se renombran los componentes en función de las variables iniciales que incorporan:

FACTOR 1. Esta componente engloba al conjunto de atributos que se concentran en la encuesta como pertenecientes al grupo **"Relacionamiento con la Empresa".** Este factor explica por sí mismo casi la tercera parte (33,5%) de la varianza total (Tabla 1).

FACTOR 2. Esta componente contiene seis variables que marcan la inclinación a la innovación por parte del estudiante. Llamaremos a esta componente el factor de **"Innovación",** el cual explica casi el 16% de la varianza total (Tabla 1).

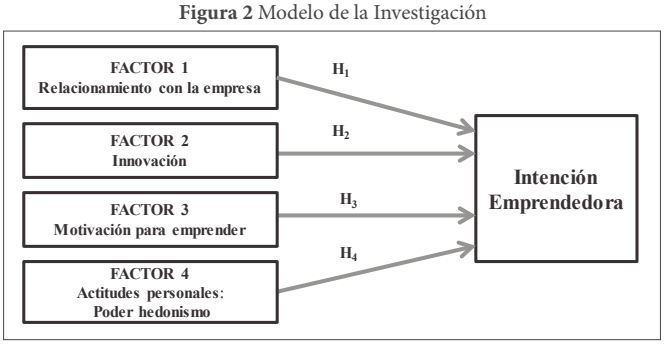
FACTOR 3. Incluye seis características que pueden denominarse **"Motivación para Emprender".** Este componente explica aproximadamente el 7% de la varianza total. (Tabla 1).

FACTOR 4. Dos variables conforman este componente: 'El logro' y 'El placer'. Se llamará a este factor: **"Actitud Personal: Poder-Hedonismo"**, explicando casi el 5% de la varianza total (Tabla 1).

A partir de los factores extraídos por ACP se propone el siguiente modelo teórico de investigación:

Modelo teórico de investigación

Figura 2 Modelo de la Investigación



Las cuatro hipótesis del modelo teórico de investigación son:

H_1: "El relacionamiento con la empresa tiene un efecto positivo en la intención emprendedora de los estudiantes universitarios"
H_2: "La Innovación tiene un efecto positivo en la intención emprendedora"
H_3: "La motivación para emprender tiene un efecto positivo en la intención emprendedora"
H_4: "Las actitudes personales (Poder/Hedonismo) tienen un efecto positivo en la intención emprendedora"

Estas hipótesis fueron estadísticamente testeadas mediante la construcción y utilización de un modelo de regresión logística ordenada cuya variable explicada fue la intención emprendedora de los estudiantes universitarios y cuyas variables explicativas fueron las puntuaciones factoriales de los 4 componentes seleccionados por ACP.

El conjunto de los 4 factores obtenidos del ACP son utilizados como insumo en un modelo de regresión ordinal logística con el fin de probar las hipótesis del modelo teórico de investigación y generar una ecuación matemática que permita predecir la intención emprendedora de un estudiante universitario a partir de esos cuatro factores y variables de control.

La variable dependiente (explicada) es Intención Emprendedora y las independientes son: FACTOR 1 ("Relacionamiento con la Empresa"), FACTOR 2 ("Innovación"), FACTOR 3 ("Motivación para Emprender"), FACTOR 4 ("Actitud Personal: Poder-Hedonismo"), REGIÓN, PIB (Producto Interno Bruto del país).

Estas variables se detallan a continuación:

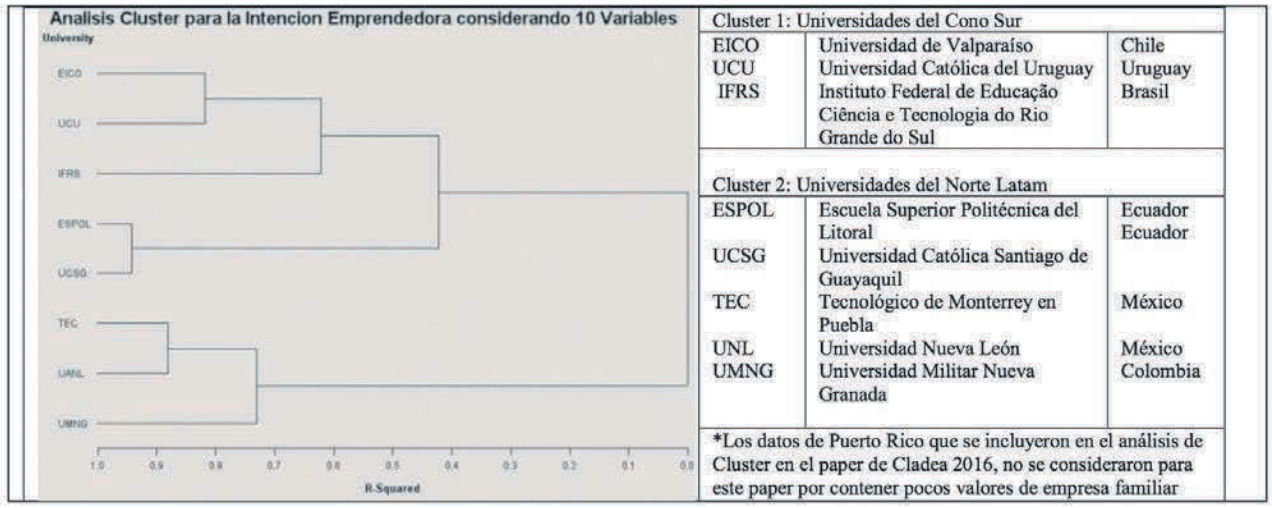
· Variable dependiente
Intención emprendedora del estudiante universitario de acuerdo a su respuesta. Los valores posibles son 1, 2, 3, 4 o 5. Las categorías de la variable respuesta presentan un orden intrínseco, por esta razón, para explicar su variabilidad es necesario el ajuste de un modelo de regresión logística ordenada.

· Variables independientes
Factores 1 a 4 del ACP: puntuaciones obtenidas por el método de Bartlett de los 4 factores extraídos mediante el análisis de componentes principales

Variable de control: Logaritmo natural del Producto Interno Bruto del país (USD) (Banco Mundial , 2016)

Variable de Control: Región donde se encuentra la Universidad. En un estudio previo realizado por este equipo utilizando esta misma base de datos se analizó la relación entre la intención emprendedora, actitudes emprendedoras personales, la motivación institucional y el apoyo familiar a la hora de emprender, concluyendo que la intención de emprender era significativamente mayor en las universidades del Norte (Colombia, Ecuador y México), que en las del Sur del continente (Brasil, Chile y Uruguay). . La Figura 3 muestra los resultados del análisis de conglomerados, observándose un agrupamiento de las universidades participantes del estudio de acuerdo a su posición geográfica en el continente. El cluster 1 (Sur) lo conformaron Universidades de Brasil, Chile y Colombia, mientras que en el cluster 2 se localizaron las Universidades de Colombia, Ecuador y México.

Figura 3 Análisis de conglomerados



Cluster 1: Universidades del Cono Sur		
EICO	Universidad de Valparaíso	Chile
UCU	Universidad Católica del Uruguay	Uruguay
IFRS	Instituto Federal de Educação Ciência e Tecnologia do Rio Grande do Sul	Brasil
Cluster 2: Universidades del Norte Latam		
ESPOL	Escuela Superior Politécnica del Litoral	Ecuador
UCSG	Universidad Católica Santiago de Guayaquil	Ecuador
TEC	Tecnológico de Monterrey en Puebla	México
UNL	Universidad Nueva León	México
UMNG	Universidad Militar Nueva Granada	Colombia
*Los datos de Puerto Rico que se incluyeron en el análisis de Cluster en el paper de Cladea 2016, no se consideraron para este paper por contener pocos valores de empresa familiar		

Para la obtención del objetivo final se desarrolló un modelo de regresión logística ordinal, donde la variable dependiente es el grado de intención emprendedora del estudiante universitario. Se probó primero que el modelo es adecuado para los datos de esta muestra, comparando la bondad de ajuste de un modelo solo con intercepto versus el modelo con todas las variables explicativas (Tabla 2).

Tabla 2 Información sobre el ajuste del Modelo

Modelo	-2 Log de la Verosimilitud	Chi-Square	df	Sig.
Sólo intercepto	1853,977			
Final	1559,052	294.925	6	,000

Link function: Logit.

Se presenta la prueba de hipótesis del estudio: ***H_0: el modelo es adecuado sólo con la constante.***

H_1: el modelo no es adecuado sólo con la constante.

Tabla 3 Bondad del ajuste

	Chi-Square	df	Sig.
Pearson	2976,531	2966	,442
Deviance	1559,052	2966	1,000

Link function: Logit.

Las hipótesis de la prueba son:

H_0: el modelo se ajusta adecuadamente a los datos
H_1: el modelo no se ajusta adecuadamente a los datos

Debido a que los p-valores de las pruebas son mayores que 0,05, no se rechaza la hipótesis nula. Por tanto, el significado estadístico que resulta indica que el modelo con las variables introducidas se ajusta adecuadamente a los datos.

La Tabla 4 muestra, para este tipo de modelos, medidas equivalentes al coeficiente de determinación R^2 de los modelos linealesque resumen la proporción de la variabilidad en la variable dependiente (intención emprendedora) asociada con los factores de predicción (variables independientes).Estos valores del pseudo-r cuadrado son muestras de la variabilidad explicada por el modelo, y en ellas se observa que el R^2 Nagelkerke estima en un 34,9% tal variabilidad.

Debido a que el p-valor de la prueba es menor que 0,05, se rechaza la hipótesis nula. Por tanto, el significado estadístico que resulta indica que el modelo con las variables introducidas mejora el ajuste de forma significativa respecto al modelo con sólo la constante.

En la siguiente tabla (Tabla 3) se presenta el test de chi-cuadrado de Pearsony el estadístico derivado de chi-cuadrado de desviación, el cual tiene por objeto comprobar si los datos observados son incompatibles con el modelo ajustado.

Tabla 4 Pseudo R-Square

Cox and Snell	.318
Nagelkerke	.349
McFadden	.159

Link function: Logit.

La Tabla 5 muestra la estimación de los parámetros del modelo, sus errores estándares, la prueba chi-cuadrado de Wald de significación de cada variable y el intervalo de confianza del 95% para cada parámetro. Se observa que todas las variables resultaron estadísticamente significativas considerando un nivel de significaron del 10% (todos los valores-p fueron menores a 0,10). Los Factores 1 (Relacionamiento con la Empresa) y 3 (Motivación) fueron altamente significativos (valores-p < 0,001). Las variables de control 'Región' y 'PBI' (tomado como logaritmo natural) también resultaron altamente significativas (valores-p = 0,26 y 0,006 < 0,05). Los Factores 2 (Innovación, valor-p = 0,059 > 0,05) y 4 (Act.Personales, valor-p = 0,091> 0,05) fueron marginalmente no significativos al 5% .

El modelo de regresión logística ordenada que corresponde a la salida de la Tabla 5 es:

$$(7)\quad Ln\left(\frac{P(Intencion\ Emprendedora \le m)}{1-P(Intencion\ Emprendedora \le m)}\right) = \tau_m - \beta_1 Factor1 - \beta_2 Factor2 - \beta_3 Factor3 - \beta_4 Factor4 - \beta_5 Ln(PBI) - \beta_6 (Region = 1)$$

con m = 1,2,3,4 y 5

Despejando da como resultado la ecuación de probabilidad acumulada:

$$(8)\quad P(Intencion\ Emprendedora \le m) = \frac{1}{1+\exp\left[(\tau_m - \beta_1 Factor1 - \beta_2 Factor2 - \beta_3 Factor3 - \beta_4 Factor4 - \beta_5 Ln(PBI) - \beta_6 (Region = 1)\right]}$$

A partir de la Tabla 5 se puede concluir:

Los coeficientes estimados de la regresión logística ordenada indican el cambio esperado en la intención emprendedora del estudiante (medido en la escala de *'odd'* o *'chance'* de aumentar la categoría de intención emprendedora) por cambio unitario en el valor de la variable correspondiente. Podemos observar que los cuatro Factores que resultaron del análisis de Componentes Principales tuvieron un efecto positivo en la intención emprendedora (todos los coeficientes estimados fueron mayores de 0). De ellos el Factor 3 (Motivación, $\widehat{\beta_3}$ =1,249) tuvo el mayor impacto en la intención emprendedora (esto es, la intención emprendedora aumenta en promedio 1,249 unidades

por cada incremento unitario del valor del Factor 3). El Factor 1 (Relacionamiento con la Empresa, $\widehat{\beta_1}$ =0,411), Factor 2 (Innovación, $\widehat{\beta_2}$ =0,148) y Factor 4 (Actitudes personales, $\widehat{\beta_4}$ =0,129) le siguieron en orden de la magnitud del impacto en la intención emprendedora.

Las cuatro hipótesis del modelo teórico de investigación se verifican al 10% de significación. Esto es, los factores definidos como 'Relacionamiento con la Empresa' (valor-p < 0,001), 'Innovación' (valor-p = 0,059), 'Motivación' (valor-p < 0,001) y las 'Actitudes Personales' (valor-p = 0,091) tienen un efecto significativo y positivo sobre la intención emprendedora de los estudiantes universitarios. Valores altos de estos factores están asociados a valores altos en la intención emprendedora. Considerando un nivel de significación del 5%, solo los Factores 1 (Relacionamiento con la Empresa) y 3 (Motivación) resultaron significativos. El Factor 2 (Innovación) resulto marginalmente insignificantico al 5%.

Se observó un efecto significativo de la Región sobre la intención emprendedora de los estudiantes universitarios (valor-p= 0,026 < 0,05). El valor del parámetro estimado del efecto para la Región 1 (SUR) fue de $\widehat{\beta_3}$ =-0,520. Esto es, -0,520 es el cambio esperado en la intención emprendedora (medida en la escala de 'chance') entre las regiones Sur (Región 1) y Norte (Región 2), manteniendo todas las otras variables constantes. En otras palabras, las chances de que un estudiante muestre una alta intención emprendedora son mayores en la Región Norte que en la Sur, siendo esta diferencia significativa a un nivel del 5%. El PBI del país (tomado como logaritmo natural) resultó una variable de control significativa en el modelo (valor-p = 0,006).

En conclusión, se observa que la intención emprendedora de los estudiantes universitarios es mayor cuando aumentan los valores que integran los Factores resultantes del ACP (Relacionamiento con la empresa, Innovación, Motivación, Actitudes Personales) y el estudiante pertenece a los países que integran la Región Norte del continente.

Tabla 5 Estimación de los parámetros

		Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Threshold	[Intención_Emprendedora = 1.0]	-21,587	6,293	11,769	1	,001	-33,920	-9,254
	[Intención_Emprendedora = 2.0]	-20,630	6,289	10,760	1	,001	-32,956	-8,304
	[Intención_Emprendedora = 3.0]	-19,036	6,281	9,185	1	,002	-31,347	-6,725
	[Intención_Emprendedora = 4.0]	-17,555	6,275	7,827	1	,005	-29,853	-5,257
Location	Ln(PBI)	-1,784	,647	7,593	1	,006	-3,053	-,515
	Factor 1 (Relacionamiento con la empresa)	,411	,089	21,370	1	,000	,237	,585
	Factor 2 (Innovación)	,148	,078	3,572	1	,059	-,005	,302
	Factor 3 (Motivación)	1,249	,085	214,615	1	,000	1,082	1,416
	Factor 4 (Act.Personales)	,129	,076	2,853	1	,091	-,021	,278
	Región=1 (Sur)	-,520	,234	4,965	1	,026	-,978	-,063
	Región=2 (Norte)	0[a]	.	.	0	.	.	.

Link function: Logit.

Comentarios finales

La intención emprendedora en los estudiantes universitarios es un tópico central en la investigación en emprendedurismo. El principal aporte de esta investigación es proveer un nuevo ángulo a través del planteamiento de una ecuación matemática que permita cuantificar y predecir la intención emprendedora de un estudiante universitario a partir de los 4 factores y variables de control, que deberá ser probada en futuras investigaciones para analizar su validez en otras muestras. De la investigación se puede confirmar que el Factor 3 (Motivación, $\widehat{\beta_3}$ =1,249) tuvo el mayor impacto en la intención emprendedora.

A su vez las cuatro hipótesis del modelo teórico de investigación se verifican al 10% de significación. Esto es, los actores definidos como 'Relacionamiento con la Empresa' (valor-p < 0,001), 'Innovación' (valor-p = 0,059), 'Motivación' (valor-p < 0,001) y las 'Actitudes Personales' (valor-p = 0,091) tienen un efecto significativo y positivo sobre la intención emprendedora de los estudiantes universitarios.

En nuestro estudio anterior se analizó el efecto de las regiones a través de un análisis de cluster. El presente estudio confirma el efecto significativo de la Región sobre la intención emprendedora de los estudiantes universitarios (valor-p= 0,026 < 0,05). Esto es, los estudiantes de la región Norte de Latinoamérica (Ecuador, Colombia y México) tiene una probabilidad más alta de volverse emprendedores que los de la región Sur (Brasil, Chile y Uruguay).

Para futuras investigaciones se sugiere realizar un análisis cross-cultural entre los países analizados, dado que el modelo del TBP sugiere que las normas subjetivas son antecedentes importantes de la intención empresarial que depende de la cultura nacional según las dimensiones culturales por país, donde se analicen los niveles tanto profesionales como organizacionales, y la forma de compartirla de una sociedad (Choia y Hofstede, 2016).

Limitaciones: la muestra analizada fue voluntaria de estudiantes que estaban realizando algún curso de emprendimiento de carreras empresariales e ingeniería y que sus familias tuvieran empresa familiar.

Futuras investigaciones: consideramos interesante realizar un estudio en otras universidades o en carreras que no contengan cursos de emprendimiento para contrastar los resultados obtenidos.

Agradecimientos

Se agradece el aporte de la **RLIE Red Latinoamericana de Innovación y Emprendimiento de CLADEA**, que permitió generar los lazos para realizar la investigación, y en especial al TEC de Puebla que aportó el instrumento modificado por los investigadores, así como a los miembros de la RED que aportaron los datos de sus estudiantes: Margarita Herrera PhD y Lizbeth González PhD, Tecnológico de Monterrey en Puebla, México; Dra. Mónica Blanco Jiménez, PhD, Universidad Autónoma de Nuevo León; Leslie Bridshaw Araya Mag, Universidad de Valparaíso, Chile; Carolina Ortiz Riaga Mag, Universidad Militar Nueva Granada, Colombia; Shana Sabbado Flores PhD y Claudio Vinícius Silva Farias PhD, Instituto Federal de Educação Ciência e Tecnologia do Rio Grande do Sul, Brasil; Nancy Wong Laborde PhD, Carmen Padilla Lozano, PhD (c) y Danny Arévalo Avecillas PhD (c), Universidad Católica Santiago de Guayaquil, Ecuador ; María Paulina Brito Ochoa MBA, Escuela Superior Politécnica del Litoral, Ecuador; Gisela I. Carrero Morales PhD y Carmen L. Rivera Hernández MBA, Universidad Interamericana de Puerto Rico Recinto de Bayamón.

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Anexo:

Resultados del Análisis Factorial de Factor 1:	Valor Propio	Varianza Explicada	Fiabilidad
Factor 1. Relacionamiento con la empresa		61,228	0,904
44. Relación con la empresa	0,749		
45. Relación con los propietarios	0,814		
46. Sacrificio por la empresa	0,865		
47. Acciones para mejorar la empresa	0,871		
48. Carrera relacionada con empresa familiar	0,704		
49. Experiencia en otra empresa	0,578		
50. Dirigir la empresa	0,822		
52. Disfruta trabajar en la empresa	0,814		
(KMO=0,906; X^2Bartlett (28) =4226,665; p<0.000; Varianza total explicada 61,228)			

Resultados del Análisis Factorial de Factor 2	Valor Propio	Varianza Explicada	Fiabilidad
Factor 2: Innovación		69,279	0,910
54. Nuevos productos en los 5 años anteriores	0,812		
55. Innovaciones propias en los 5 años anteriores	0,795		
56. Impacto económico de las innovaciones sobre las ventas en los 5 años anteriores	0,856		
57. Nuevos métodos de producción en los 5 años anteriores	0,842		
58. Rol de la investigación en los 5 años anteriores	0,849		
59. Influencia de factores financieros en los 5 años anteriores	0,838		
(KMO=0,909; X^2Bartlett (15) = 3557,693; p<0.000; Varianza total explicada 69,279)			

Resultados del Análisis Factorial de Factor 3:	Valor Propio	Varianza Explicada	Fiabilidad
Factor 3: Motivación para emprender		52,267	0,814
23.b El logro	0,784		
23.d La estimulación	0,704		
23.e La autodirección	0,787		
23.g Liderazgo	0,648		
23.h Motivación institucional para emprender	0,669		
23. i Apoyo familiar para emprender	0,734		
(KMO=0,858; X^2Bartlett (15) = 5770,262; p<0.000; Varianza total explicada 52,267)			

Resultados del Análisis Factorial de Factor 4	Valor Propio	Varianza Explicada	Fiabilidad
Factor 4: Actitud Personal: Poder Hedonismo		68,716	0,545
23.a. El poder	0,829		
23.c El placer	0,829		
(KMO=0,500; X^2Bartlett (1) = 501,249; p<0.000; Varianza total explicada 68,716)			

ISSN: 0718-2724. (http://jotmi.org)

Enseñanza superior y sociedad: un estudio exploratorio sobre prácticas de la tercera misión en la Universidade Estadual de Campinas (Unicamp)

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Resumen: Este artículo presenta los resultados del estudio realizado sobre la tercera misión en la Universidade Estadual de Campinas (Unicamp), así como presenta un esbozo conceptual de la tercera misión, con base en estudios de referencia en ese campo, especialmente enfatizando los enfoques que posibilitan una visión multidimensional de la relación universidad-sociedad. Se utilizaron fuentes primarias (entrevistas y cuestionarios) y secundarias (informes institucionales, anuarios estadísticos y bibliografía especializada). Se concluye que la Unicamp está involucrada en diversas actividades de la tercera misión, sin embargo, los resultados también indican que la falta de comunicación y de intercambio de informaciones, las visiones estrechas de la relación universidad-sociedad y las reducidas concepciones de la extensión universitaria y de la tercera misión están entre las realidades que limitan e impiden el establecimiento de una comprensión holística de la tercera misión.

Palabras clave: tercera misión; extensión; desarrollo regional; compromiso social; transferencia de tecnología.

Abstract: *Higher education and society: an exploratory study on practices of the third mission at the University of Campinas (Unicamp)*
This article presents the partial results of a study that investigated the third mission at the University of Campinas (Unicamp), as well as a conceptual outline of the third mission, based on reference studies in this field, especially emphasizing the approaches that would allow a multidimensional view of the university-society relationship. We used primary sources (interviews and questionnaires) and secondary sources (institutional reports, statistical yearbooks and specialized bibliography). It is concluded that Unicamp is engaged in several activities of the third mission, however, the results also indicate that the lack of communication and exchange of information, the close visions of the university-society relationship and the narrow conceptions of university extension and the third mission are among the realities that limit and hinder the establishment of a holistic understanding of the third mission.

Keywords: third mission; extension; regional development; social engagement; technology transfer

Submitted: August 5th, 2018 / Approved: November 21st, 2018

1. Introducción

Cada vez más se entiende que las instituciones de enseñanza superior (IES) y, especialmente, las universidades intensivas en investigación, deben estrechar los vínculos con la sociedad asumiendo mayor visibilidad, prestando servicios, promoviendo el emprendedorismo y la innovación y contribuyendo más activamente al desarrollo socioeconómico local/regional. De este modo, en el siglo XXI, se exige cada vez más que las IES extiendan y refuercen sus acciones más allá de sus muros, considerando todos los posibles impactos que esas acciones puedan promover - sobre la comunidad, sobre las empresas, sobre los gobiernos locales, sobre las instituciones y organizaciones de su entorno. Este conjunto de relaciones ha sido considerado como integrante de la tercera misión (siendo que la primera es la enseñanza y la segunda es la investigación).

Lo que se nota es que ha sido bastante común asociar la tercera misión directamente con actividades de capitalización de conocimiento, emprendedorismo, innovación y transferencia de tecnología. Por otro lado, todas las actividades ajenas a esas relaciones, pero que también involucran la relación universidad-sociedad suelen ser nombradas de extensión (actividades culturales, cursos, proyectos sociales y otros). Sin embargo, diversos esfuerzos internacionales han contribuido a la evolución del entendimiento de la relación universidad-sociedad a partir de la creación de un cuerpo de conocimientos en ese campo, apuntando a la urgencia de un tratamiento más amplio, que se libere de esa visión polarizada. Estos estudios sostienen que la "tercera misión" representa un conjunto amplio de interacciones de la universidad con la sociedad, según lo presentado por Molas-Gallart, Salter, Patel, Scott y Duran (2002); Schoen (2006); Grao, Iriarte, Ochoa y Vieira (2014); European Indicators and Ranking Methodology for University Third Mission - E3M (2012); D'Este, Castro-Martínez y Molas-Gallart (2014), Mora y Vieira (2014) y otros.

Por lo tanto, el estudio se justifica porque se nota que, aunque la comprensión del papel de la universidad ha evolucionado, la idea de tercera misión todavía suscita muchas discusiones, no sólo desde el punto de vista conceptual, sino principalmente en lo que se refiere a su alcance, es decir, a los tipos de actividades y relaciones abarcadas por el concepto. En vista de estas evidencias, el presente artículo fue estructurado para que fuera posible presentar los resultados parciales de la investigación conducida a nivel de doctorado, que investigó las múltiples caras de la relación universidad-sociedad, o sea, de la realización de la tercera misión en la Universidade Estadual de Campinas (Unicamp).

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ISSN: 0718-2724. (http://jotmi.org)

Esta investigación tuvo fines exploratorios y descriptivos y el abordaje adoptado fue el cualitativo. Además de las fuentes bibliográficas que estructuraron el referencial teórico-conceptual, también se utilizaron las siguientes fuentes: documentos institucionales - anuarios estadísticos; informes de actividades; con vistas a la identificación de las iniciativas de la universidad en ese campo; y también cuestionarios y entrevistas, para identificar los desafios y limitaciones para realización de la relación universidad-sociedad en la Unicamp. Además de esta introducción y de las conclusiones, el artículo está compuesto por otras tres partes que son las siguientes: marco teórico-conceptual, con una breve presentación de las misiones universitarias, especialmente la evolución de la tercera misión; procedimientos metodológicos, que aclara aspectos específicos de la recolección de los datos empíricos en la Unicamp; presentación y discusión de los resultados.

Los hallazgos de la investigación permitieron concluir que la Unicamp está activamente involucrada en la conducción de varias iniciativas de la tercera misión. Además de destacarse en el escenario nacional, especialmente en el campo del emprendedorismo, innovación y transferencia de tecnología. Sin embargo, todavía existen cuestiones que necesitan ser perfeccionadas, como la mejora de los canales de comunicación, la interacción y la promoción de sinergias entre las diversas instancias que promueven la relación universidad-sociedad, es decir, de la tercera misión de la universidad.

2. Marco teórico

2.1 Universidad: origen y misiones

Los diversos autores sostienen que, aunque ya existiese la enseñanza superior en Grecia, en Roma y en el mundo musulmán, fue sólo a partir del siglo XI que se puede hablar de un tipo de enseñanza muy próximo a lo que conocemos hoy: facultades, currículos (con definición de asuntos, programas y tiempo de estudios), exámenes, grados académicos, etc. y eso es una herencia directa, no de Atenas o de Alejandría, sino de París (1170) y Bolonia (1088) (Haskins, 2007). La enseñanza que predominó era esencialmente escolástica, cuyo origen se remonta a las escuelas monásticas cristianas. Los maestros leían textos de las autoridades (grandes pensadores), con el fin de transmitir al estudiante el conjunto de saberes de la disciplina y, posteriormente, se realizaban debates (*disputatio*) en torno a una cuestión (*quaestio*) (Durkheim, 1995). Como guardián de los valores de su época, la universidad contribuyó al mantenimiento del status quo, reforzando las estructuras de poder, alimentando las filas de los cuerpos eclesiásticos y estatales, o apenas instruyendo a las élites (Giordani, 1982). No había la idea de un "papel de la universidad ante la sociedad, de servicios a ser prestados a la comunidad extramuros" (Castanho, 2000, p. 24).

La institucionalización de la investigación, como una función de la universidad ocurrió en Alemania, en la primera década del siglo XIX (1809/1810), con la creación de la Universidad de Berlín. Su principal idealizador, Wilhelm von Humboldt, entendía que la investigación contribuiría no sólo al avance de la ciencia, sino también a la mejora de la misión de enseñanza, es decir, una retroalimentaria a otra. Según Ribeiro (1982), al implantarse precozmente en la universidad, la ciencia preparó el camino para la industrialización de Alemania al formar recursos humanos especializados para sostenerla, lo que garantizó el desarrollo de una industria química y metalúrgica capaz de competir con las potencias industriales de la época.

Se afirma que la tercera misión surgió en el siglo XIX, en Inglaterra, en Oxford y en Cambridge, cuando comenzaron a delinear las bases de la extensión universitaria. Mackinder y Sadler (1891) afirman que el uso del término "extensión universitaria" surgió en la Universidad de Oxford alrededor de 1845 y se hizo corriente en los años subsiguientes. Entre los años 1867 y 1873, en la Universidad de Cambridge, se aprobaron diversas propuestas de organización de cursos y conferencias para ser llevados a institutos de mecánica, cooperativas, escuelas y otras agremiaciones, especialmente en el norte de Inglaterra, creando las bases para las futuras escuelas o departamentos de extensión universitaria y de educación de adultos en todo el mundo (Welch, 1973).

La extensión universitaria, en la modalidad de prestación de servicios, surgió en los Estados Unidos, con los Land-Grant Colleges, con autorización de una ley federal (Morrill Act - 1862) permitió la donación de tierras federales para el financiamiento de universidades públicas (por regla general, aunque las universidades privadas también han sido financiadas), especialmente para la promoción del desarrollo agrícola e industrial. Según Kerr (2005, p. 25), "el movimiento de concesión de tierras abrió las puertas de las universidades a los hijos de los agricultores y trabajadores, que se sumaron a los hijos de las clases media y alta; introdujo estaciones de experimentación agrícola y oficinas de servicios". Finalmente, fue en los Estados Unidos, a mediados del siglo XX que la universidad pasa a involucrarse con el emprendedorismo, innovación y actividades de transferencia de tecnología, parques tecnológicos, entre otros, teniendo como paradigmas el Massachusetts Institute of Technology (MIT) y la Stanford University.

Actualmente, crecen los debates en favor de la Glocal University, que es la universidad con alcance global y localmente involucrado (Grau, 2014), es decir, no son sólo centros de prestigio internacional pero también están involucrados con las demandas de sus regiones, pues en el siglo XXI se espera que los centros de conocimiento desarrollen una misión regional (Arbo & Benneworth, 2007). La misión regional puede entenderse como "una tarea formal o un deber atribuido a una colectividad o grupo de personas (en este caso, una universidad), concerniente al desarrollo más amplio de sus alrededores geográficos inmediatos" (Pinheiro, 2011, p. 9).

2.2. Tercera misión: recorte conceptual

Etzkowitz Y Leydesdorff (1997) son comúnmente señalados como los creadores del término tercera misión, o al menos como los autores que popularizaron el uso del término, que acabó extendiéndose por los medios académicos y empresariales, pasando a ser asociando con innovación, emprendimiento y asuntos relacionados. Los autores también son conocidos como los creadores del enfoque de la "Triple Hélice" que se preocupa por los arreglos institucionales modelados para la interacción entre universidad-industria-gobierno, atribuyendo a la universidad un papel central en la sociedad basada en el conocimiento. En ese marco, la tercera misión representaría la contribución al desarrollo económico y social.

Para Roessler, Duong y Hachmeister (2015), la tercera misión es un "fenómeno global con características locales" cuyos entendimientos varían en cuanto al alcance, convirtiéndose cada vez más en un enfoque multidimensional que comporta dimensiones culturales y sociales, así como políticas y económicas. Göransson, Maharajh y Schmoch (2009, p. 158) llaman la atención sobre lo siguiente: "el debate internacional sobre la tercera misión ha sido ampliamente dominado por el modelo norteamericano, pero hay que averiguar si tal modelo puede ser transportado a otros países, especialmente para en desarrollo". Por lo tanto, es necesario considerar que la discusión sobre las actividades que deben o no incluir en la definición de la tercera misión varían considerablemente entre los países y en diferentes contextos.

Fernández-Larrea y González (2013, p. 8) entienden que la interacción universidad-sociedad se realiza a través de la extensión universitaria, que "es el proceso que tiene como propósito promover cultura en la comunidad intra y extrauniversitaria como parte de la contribución universitaria al desarrollo cultural". Los autores sostienen que el modelo de extensión autual está defesado:

> no es suficiente ofrecer servicios a determinados sectores externos, no basta a la universidad extender puentes a la sociedad, sin reflexionar sobre los significados de esas acciones, sino que es necesario repensar por entero su actuación con una perspectiva social. Esto exige que la universidad se reconstruya internamente, teniendo en consideración la realidad sociocultural de la cual participa. Por eso no debe solo mirar hacia fuera; debe repensarse desde su interior, lo más importante es reflexionar sobre sus significados y sobre su papel en la construcción de la sociedad en estos nuevos contextos, ya que debe contribuir al conocimiento y a la solución, en su ámbito y de acuerdo a sus posibilidades, de los problemas y necesidades de la sociedad (Fernández-Larrea & González, 2013, p. 9).

Otro aspecto a tener en cuenta es que, en América Latina, en general, la extensión tiene una connotación diferente de los enfoques de la tercera misión de los países desarrollados, o sea, en nuestra región, la extensión ha sido entendida como difusión cultural y como servicios sociales dirigidos a grupos desfavorecidos. Sin embargo, aunque algunos sectores de la universidad son contrarios a la aproximación de la universidad de las demandas del sector productivo, actualmente, el concepto de extensión se conecta cada vez más al de tercera misión. Por lo tanto, los dos conceptos deben orientar la transferencia de conocimiento a la sociedad, incluyendo entre sus prácticas / acciones / actividades, inclusive, el espíritu emprendedor y la innovación (Grao, Iriarte, Ochoa & Vieira, 2014).

Schoen y Thèves (2006) y Inzelt et al. (2006) afirman que es por medio de la tercera misión que se determina la forma en que los recursos y las capacidades de la universidad se integran a la economía y a la sociedad. Esta misión es multifacética y presenta dimensiones económicas - como la transferencia de conocimiento y tecnologías, a través de licencias y contratos con la industria; y dimensiones sociales - como la participación en la vida social y cultural. Además, también es importante considerar los diferentes usos del conocimiento científico según aclaran Castro-Martínez, Olmos-Peñuel y Fernandez-De-Lucio (2016, p. 123):

> en principio, las políticas de fomento de las relaciones ciencia-sociedad se diseñan con objeto de favorecer las interacciones de los investigadores con las industrias en sus procesos innovadores, por lo que implícitamente están considerando sólo el uso instrumental del conocimiento científico, pero cuando se amplía el tipo de sectores para dar cabida a los servicios – incluyendo a las administraciones públicas y otros agentes sociales – se observa que los usos conceptual y simbólico pueden presentar mayor relevancia que el instrumental.

En el Proyecto titulado "*European Indicators and Ranking Methodology for University Third Mission - E3M*", patrocinado por la Comisión Europea, se afirmó que la tercera misión se realiza cuando las actividades de producción, utilización, aplicación y explotación de conocimientos y otras capacidades de la universidad alcanzan el público externo a la academia. Además, se estableció que la tercera misión está constituida por tres dimensiones: (i) educación continuada; (ii) transferencia de tecnología e innovación; (iii) compromiso social (European Indicators and Ranking Methodology for University Third - E3M, 2012a, b, c). El Proyecto *VINCULAENTORNO*, orientado a la cooperación entre la Unión Europea y América Latina para la promoción de la educación superior como un instrumento de desarrollo social y económico, adoptó la clasificación establecida por *el European Indicators and Ranking Methodology for University Third Mission - E3M* (2012a, b, c) y también se consideró que la tercera misión presenta tres dimensiones (educación continuada, transferencia de tecnología e innovación, compromiso social) (Mora y Vieira, 2014).

En el Brasil, en virtud de la Constitución Federal de 1988, las universidades deben realizar la enseñanza, la investigación y la extensión y se percibe que ese direccionamiento legal acabó por establecer que la extensión universitaria es la tercera misión de la universidad. Sin embargo, el concepto de extensión universitaria, así como su alcance todavía carecen de entendimiento. Entendemos que la utilización del término extensión se ha mostrado limitada para representar todas las posibles relaciones de la universidad con la sociedad, en función de la enseñanza, de la investigación, y de sus capacidades físicas y de conocimiento.

En el ámbito de las universidades públicas brasileñas, el Foro Nacional de Pro-Rectores de Extensión de las Universidades Públicas (FORPROEX), formado por Pró-rectores/Vicerrectores de Extensión de las universidades participantes, por ejemplo, ha sido el responsable por la creación de un cuadro conceptual, así como por la organización y sistematización de la extensión. Según el Foro, "la extensión universitaria es el proceso educativo, cultural y científico que articula la enseñanza y la investigación de forma indisociable y viabiliza la relación transformadora entre la universidad y la sociedade" (Forproex, 1987, p. 11). Aunque el Foro reconoce que las actividades relacionadas con el espíritu emprendedor, la innovación, la propiedad intelectual y la transferencia de tecnología en las universidades pueden considerarse como extensión, no siempre se considerarán tales actividades, ya que los resultados de estas actividades se deben originar en el marco de programas o de proyectos de extensión, situación relativamente rara de ocurrir, especialmente porque las investigaciones que pueden

generar invenciones, patentes y transferencia de tecnología involucra sigilo, mientras que el propósito de la extensión es la publicidad, la coproducción y el compartir. Por lo tanto, cuando tales actividades (emprendedorismo, innovación, patentamiento, etc.) no se realizan en el ámbito de la extensión, ¿cuál sería su clasificación o el nombre que esas relaciones deberían recibir? Otra cuestión que también merece destacarse es que incluso las actividades más tradicionales y típicamente integrantes de la extensión, como los cursos, no son reconocidas y aceptadas de forma unánime por algunos grupos dentro de las universidades, especialmente las disciplinas y los cursos pagados, habiendo preferencia por las acciones culturales, artísticas y comunitarias, en algunos casos.

En vista de estas evidencias es que optamos por nombrar la relación universidad-sociedad de "tercera misión", tomando como ejemplo iniciativas internacionales en ese sentido (Proyecto E3M y Proyecto VINCULAENTORNO, citados anteriormente) que se preocuparon por crear un marco conceptual que permitiese una visión holística de la relación universidad-sociedad. Siendo así, entendemos que la tercera misión es la interfaz que une a la universidad de forma más directa a la sociedad, con el apoyo de las instalaciones físicas y las capacidades de conocimiento, o sea, representa la articulación de las misiones enseñanza e investigación y de diversos mecanismos e instrumentos que comprenden tanto la estructura física - bibliotecas, museos, laboratorios, instalaciones destinadas al deporte, a la cultura y al ocio, entre otras; como también por intermedio de las existencias de conocimiento y de las capacidades y habilidades de la comunidad académica.

3. Procedimientos Metodológicos

3.1 Identificación de las actividades de la tercera misión: criterios utilizados

Para el escrutinio y clasificación de actividades de la tercera misión en la Universidade Estadual de Campinas (Unicamp) se adoptaron las tres dimensiones conceptuales establecidas por el "*European Indicators and Ranking Methodology for University Third Mission* - E3M", que se llevó a cabo entre enero de 2009 y diciembre de 2012. Este proyecto estableció que la tercera misión está formada por tres dimensiones, que son: (i) dimensión transferencia de tecnología e innovación; (ii) dimensión de la educación continuada; (iii) dimensión compromiso social. Posteriormente, entre 2012 y 2014, el Proyecto VINCULAENTORNO, que contó con la participación de universidades de América Latina (incluida la Unicamp), también adoptó la referida clasificación. Los dos proyectos citados (E3M y VINCULAENTORNO) representan acciones en pro de la comprensión de la tercera misión desde un punto de vista holístico de las diversas posibilidades de acción, por lo que adoptamos la referida clasificación.

La *dimensión innovación y transferencia de tecnología* promueve la diseminación y aplicación del conocimiento, experiencias, entre otras, resultantes de las actividades de investigación desarrolladas en la universidad. Es la interfaz entre la investigación universitaria y el mundo no académico (comunidad, sociedad) y eso puede involucrar: protección a la propiedad intelectual; contratos de licencias; establecimiento de estructuras de apoyo a la innovación y al espíritu empresarial (incubadoras, parques científicos y tecnológicos, oficinas de transferencia de tecnología); compartiendo y alquilando laboratorios y otros espacios, entre otras acciones (E3M, 2012a, b, c). En la *dimensión educación continuada* interesan los procesos formativos que posibiliten el perfeccionamiento de habilidades y competencias individuales y el aumento del nivel de conocimiento, es decir, se refiere a la educación y la formación. En esta dimensión importa esencialmente determinar cómo y cuáles son las iniciativas desarrolladas por las universidades para extender los beneficios del conocimiento y de la educación superior a grupos no tradicionales de estudiantes, es decir, a los que no son alumnos regulares de la graduación o del postgrado. La *dimensión compromiso social* se refiere a la utilización y asignación de los recursos del conocimiento (intelectuales y físicos) de la universidad para contribuir con la comunidad o región, y en términos más amplios, con la sociedad en general. En esta dimensión es bastante común que se fusionen las actividades e iniciativas de las otras dos dimensiones, pues las fronteras entre las dimensiones no son limitadas, lo que hace que esta dimensión asuma una naturaleza híbrida. El compromiso social puede ocurrir cuando la universidad se involucra con demandas o necesidades de empresas, gobiernos locales, por ejemplo; cuando permite a la comunidad el acceso a bibliotecas, museos, teatros y otras instalaciones; al participar y estimular debates relacionados con cuestiones sociales críticas (medioambientales, por ejemplo); cuando promove el voluntariado. El ofrecimiento de cursos y disciplinas de extensión gratuitas también puede ser encuadrado en esta dimensión, así como las acciones dirigidas a la divulgación y popularización de la ciencia, la participación con acciones de economía solidaria, generación y difusión de tecnologías sociales, atención a cuestiones de salud pública, ambientales y otras necesidades urgentes de la comunidad y del entorno de la universidad también son ejemplos de compromiso social.

3.2 Selección de los entrevistados

Para la selección de entrevistados, se identificaron, primero, las principales instancias que tratan con la tercera misión y sus respectivos representantes: Directores, Pro-Rectores, asesores u otros profesionales involucrados de alguna forma con el tema. La Tabla 1 presenta la lista de instancias y la función de los entrevistados que aceptaron participar en la investigación.

Tabla 1. Unicamp: instancias seleccionadas

Unicamp	Función/Posición
Escuela de Extensión de la Unicamp	Director
	Director
Inova Unicamp	Gerente de comunicación
Instituto de Economía	Profesor[1]
Laboratorio de Periodismo Científico	Investigador y profesor
Pro-Rectoría de Extensión y de Asuntos Comunitarios	Asesor del Pro-rector
	Secretaría
Fundación de Desarrollo de la Unicamp	Director ejecutivo
Coordinación General de la Unicamp	Vicerrector

Nota 1: representó a la Unicamp en el Proyecto VINCULAENTORNO, que investigó la realización de la tercera misión en universidades latinoamericanas y europeas.

Se realizaron 9 entrevistas entre los meses de diciembre de 2015 y octubre de 2016 y el cuestionario aplicado a los entrevistados estaba compuesto por 17 cuestiones abiertas que pretendían identificar la opinión del encuestado acerca de prácticas específicas de la universidad, así como sobre las estructuras e instancias que se conectan con la sociedad.

A continuación, se presenta una síntesis de los principales resultados obtenidos con la investigación conducida en la Unicamp, iniciándose por la presentación de acciones y prácticas seleccionadas de la tercera misión (letra a), en la secuencia, se presentan las percepciones y visiones de los entrevistados letra b).

4. Resultados y Discusión

4.1. Universidade Estadual de Campinas (Unicamp): breve histórico y perfil

La Unicamp y una universidad pública del Estado de São Paulo, Brasil, creada em 1966. La universidad tiene aproximadamente 37 mil alumnos matriculados en 66 cursos de graduación y 152 programas de postgrado, mientras que el 47% de todos los alumnos están concentrados en posgrado. La Unicamp posee 1.910 profesores, de los cuales 99 % como mínimo con titulación de doctor (94% régimen actuando en Dedicación exclusiva) posee 24 unidades de enseñanza e investigación, 21 centros y núcleos interdisciplinarios, 3 hospitales, 2 escuelas técnicas y 29 bibliotecas (Unicamp, 2017). La Unicamp es una universidad joven (cumplió 50 años en 2016), pero ya conquistó tradición en la enseñanza, en la investigación y en las relaciones con la sociedad, pues es responsable de aproximadamente 8% de toda la producción científica del Brasil y de 12% de la graduación nacional. También, su complejo de salud atiende a cerca de 500 mil pacientes al año. El desempeño de la institución también viene repercutiendo internacionalmente, pues integra un grupo bastante reducido de universidades brasileñas que han aparecido en los rankings internacionales (como el Quacquarelli Symonds - QS y el Times Higher Education - THE): en el THE (2017), por ejemplo, figuró en la 1ª colocación en el ranking de América Latina; en el ranking QS (2018) de las mejores universidades de América Latina y de las 100 mejores de los BRICS, la Unicamp apareció, respectivamente, en la 2ª y en la 12ª colocación.

4.2 Las relaciones con la sociedad en la práctica: estructuras, instancias y dimensiones de la tercera misión en la Unicamp

En este ítem presentaremos instancias y acciones seleccionadas y no el conjunto de iniciativas, ni el conjunto de instancias y estructuras de la Unicamp a las que fueron institucionalmente atribuidas la función de conducir la tercera misión, pues eso extrapolaría los objetivos de la investigación. Además, es importante considerar que existen diversas acciones conducidas por instancias que tienen otras funciones institucionales que no específicamente la de servir de interfaz entre la universidad y la sociedad. Además, las unidades de enseñanza e investigación, en su gran mayoría, desarrollan periódicamente acciones dirigidas a la sociedad, tales como: eventos públicos y gratuitos, cursos, talleres, conferencias, seminarios, olimpiadas, entre muchos otros.

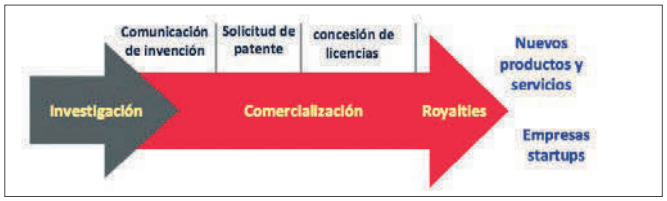
Sin embargo, existen instancias específicas cuya misión primordial es realizar la relación universidad-sociedad en la Unicamp, como la Pro-Rectoría de Extensión y Asuntos Comunitarios (PREAC), que fue creada en 1986 para "coordinar, fomentar, estimular y producir acciones de Extensión y de Cultura por la integración dialógica, interactiva y proactiva con la sociedad, difundiendo y adquiriendo conocimiento a través de la comunidad universitaria" (http://www.50anos.unicamp.br/linha-de-tempo). La PREAC tiene bajo su dirección varios órganos y estructuras, tales como: el Cultural de Inclusión e Integración Social - Cis - Guanabara; el Espacio Cultural Casa del Lago - Ecult; la Escuela de Extensión (Extecamp); el Laboratorio de Estudios e Investigaciones en Artes y Ciencias - Lepac; las emisoras de radio y televisión de la Unicamp, entre otras. Por intermedio de estos diversos órganos se realizan diversas acciones y actividades que vinculan a la Unicamp a la sociedad, sea en el campo de la divulgación y comunicación (vía radio y televisión), sea por medio del ofrecimiento de cursos de extensión universitaria, o por medio de acciones comunitarias, artísticas y culturales, entre otros. Otra instancia orientada a las relaciones con la sociedad es la Agencia de Innovación de la Unicamp (Inova Unicamp), creada en 2003, con la misión de "identificar oportunidades y promover actividades de estímulo a la innovación y al espíritu emprendedor, ampliando el impacto de la enseñanza, de la investigación y de la extensión en favor del desarrollo socioeconómico sostenido". La agencia está vinculada al Gabinete del Rector, siendo responsable por la gestión de la política de propiedad intelectual (PI) de la Unicamp, así como por la administración de la Incubadora de Empresas de la Unicamp (Incamp) y del Parque Científico y Tecnológico, además de promover la cultura en la universidad (ofreciendo cursos, capacitaciones, premiando inventores, promoviendo concursos y competiciones, entre otras acciones).

Finalmente, otra área extremadamente importante es la de la salud, cuyo alcance de los servicios prestados por la Unicamp a la comunidad de la Región de Campinas (en el estado de São Paulo) es indiscutible. Además del alcance social del área de la salud, la prestación de estos servicios se convierte también en una valiosa oportunidad para que los estudiantes adquieran competencias específicas y perfeccionen habilidades indispensables para el desempeño de la profesión. A continuación, presenta una selección de acciones de la tercera misión en la Unicamp y su encuadramiento en las respectivas dimensiones, a saber: innovación y transferencia de tecnología, educación continuada y compromiso social.

4.2.1 Dimensión innovación y transferencia de tecnologia

Con el apoyo de la Agencia de Innovación (Inova) la Unicamp se ha destacado en el ambiente de innovación nacional como una de las universidades brasileñas más exitosas en la conducción de la política institucional de protección y gestión de la protección de la propiedad intelectual generada. La experiencia de la Unicamp en ese campo se comprueba por medio de diversos indicadores, especialmente los del Instituto Nacional de la Propiedad Industrial (INPI), que la colocan entre los principales depositantes de solicitudes de patentes del país, ocupando las primeras colocaciones entre las instituciones nacionales que más depositan solicitudes de patentes ante el INPI. Entre 2000 y 2012 la Unicamp fue la primera entre las universidades y la tercera en la clasificación general (Carvalho, Jorge, Barcelos, Lopes & Pinheiro, 2015); en 2015 ocupó la tercera colocación entre las mayores patentes de Brasil y la segunda entre las universidades. En 2017, la Unicamp, fue nuevamente la primera colocada (Instituto Nacional de la Propiedad Industrial, 2018). La Figura 1 ilustra el flujo de actividades de Inova Unicamp, específicamente, su actuación en la protección de las invenciones generadas en la universidad.

Figura 1. Protección a las invenciones generadas en la Unicamp: passos



Fuente: Adaptado y traducido de Inova Unicamp (2018).

La Tabla 2 trae algunos resultados referentes a la conducción de la política de propiedad intelectual de la Unicamp, del período comprendido entre 2012 y 2016.

Tabla 2. Resultados obtenidos por Innovación en el período 2012-2016

Actividades	2012	2013	2014	2015	2016
Solicitudes de patentes depositadas en el Instituto Nacional de la Propiedad Industrial (INPI)	74	71	79	58	80
Solicitudes de patentes depositadas en el exterior	5	5	1	4	7
Solicitudes de patentes depositadas a través *Patent Cooperation Treaty (*PCT)	22	16	12	21	31
Patentes concedidas (Brasil y exterior)	11	12	15	35	31
Patentes vigentes (depositados en Brasil y en el exterior, concedidos o no)	828	874	944	993	1.042
Licencias de tecnología: contratos vigentes	52	59	57	71	87
Comunicaciones de invención recibidas	107	122	104	80	144
Solicitudes de registro de programa informático	29	16	20	12	21
Ganancias económicas, en US$: royalties, tasa de acceso a la tecnología y otros - recibidos de licencias	99,401.37	146,702.07	287,384.32	500,595.56	160,651.82
Convenios de I & D con empresas	13	15	8	26	26
Empresas incubadas	10	8	9	15	13
Empresas graduadas (acumulado)	36	37	40	44	44

Fuente: elaborado por las autoras con base en el Informe de Actividades de la Inova Unicamp 2016 (2017).

Se puede observar, por ejemplo, que la Unicamp contaba con 1.042 patentes vigentes, en 2016, así como con 87 contratos de licenciamiento de tecnología y hubo 144 comunicaciones de invención. En ese mismo año, el número total de depósitos de solicitudes de patentes fue 118 (80 junto al INPI, 7 en el exterior y 31 por intermedio del PCT). Además de los números expresivos en el campo de la protección y gestión de la propiedad intelectual, la Unicamp también ha contribuido al establecimiento de un ambiente favorable al emprendedorismo, a la innovación y a la transferencia de tecnología al instituir y diseñar eventos y estructuras formales para la realización de tales objetivos. En el campo del emprendedorismo, por ejemplo, la Unicamp desempeña un importante papel en la generación de startups (o "empresas hijas"). En 2016 existían 434 "empresas hijas" de la Unicamp activas en el mercado. Estas empresas generaron aproximadamente 22 mil empleos directos y tuvieron una facturación de más de US$ 700 millones. Se consideran empresas-hijas las empresas cuyos socios (fundador o actual) y/o las actividades están relacionados con la Unicamp de la siguiente forma: empresas de alumnos o ex alumnos (graduación o posgrado); empresas de profesores o ex profesores; empresas de personal o ex funcionarios; empresas incubadas o graduadas en la Incubadora de la Unicamp (Incamp); emprendedores que firmaron contrato de licenciamiento de tecnologías de la Unicamp, siempre que estas tecnologías sean parte fundamental de la empresa. El registro de las empresas-hijas es realizado por Inova Unicamp.

La Inova Unicamp también conduce varias otras iniciativas, como el Premio Inventores Unicamp que homenajea a profesores, investigadores, ex alumnos y alumnos que son premiados en cuatro categorías: tecnología licenciada, patentes concedidas, tecnología absorbida por el mercado y destaque en la protección a la propiedad intelectual (para las unidades de enseñanza e investigación con mayor participación en la cultura de protección de los resultados de sus investigaciones). Otra importante premiación es el "Desafío Unicamp de Innovación Tecnológica", una competencia de alcance nacional que dura en promedio tres meses y que pretende motivar a estudiantes, vinculados o no a la Unicamp, a crear modelos de negocio de base tecnológica a partir de patentes o programas de ordenador pertenecientes al Porfolio de la universidad. Durante la competición ocurren diversas actividades como talleres, charlas y mentorías. Al final del período es elegido el equipo, el que consigue conquistar el primer lugar recibe un premio en efectivo, que en 2017 fue de R$ 3.000,00 para cada integrante del equipo, además de certificado, trofeo entre otros. Es importante subrayar que las iniciativas anteriormente citadas no

representan la totalidad de las acciones llevadas a cabo por Inova Unicamp, pues la agencia actúa activamente dentro de sus atribuciones, ejerciendo un importante papel en la conducción de la política de propiedad intelectual de la Unicamp, realizando el puente entre la universidad y el sector productivo, bien divulgando y desarrollando acciones relacionadas con la innovación y el emprendimiento. Las acciones de la Agencia de Innovación de la Unicamp encuentran su razón de ser en la intensa actividad de investigación realizada en la universidad.

4.2.2 Dimensión de la educación continuada

Para representar esta dimensión se optó por averiguar la extensión universitaria, especialmente, los cursos o disciplinas ofrecidas por la Escuela de Extensión de la Unicamp (Extecamp). Los cursos y disciplinas de extensión representan formas más flexibles y rápidas de adquisición de nuevos conocimientos, actualización de conceptos y prácticas, así como calificación profesional. Para las universidades, por otro lado, pueden representar nuevos canales de ingreso de recursos financieros, además de exteriorizar su responsabilidad social o compromiso público hacia la expansión de los beneficios del conocimiento a la sociedad, fomentando las capacidades de conocimiento y de mano de obra calificada en la región, así como proporcionando condiciones de empleabilidad. En las universidades brasileñas la mayor parte de las acciones de esta dimensión quedan bajo la responsabilidad de las Pro-Rectorías de Extensión (o Vicerrectorías), siendo que los cursos y disciplinas son comúnmente centralizados y ofrecidos por las Escuelas de Extensión. La Escuela de Extensión de la Unicamp (Extecamp), creada en 1989 y está vinculada a la Rectoría de Extensión y Asuntos Comunitarios (PREAC), siendo la responsable de la administración y el ofrecimiento de los cursos formales de extensión. La Tabla 3 presenta las modalidades y los requisitos de los cursos de extensión ofrecidos por Extecamp.

Tabla 3. Modalidades de cursos de extensión ofrecidos por Extecamp

Modalidad	Carga horaria mínima (en horas)	Requisitos previos mínimos	Certificación
Perfeccionamiento profesional	180	Enseñanza superior completa	Certificado de finalización
Actualización	180	Enseñanza superior completa	Certificado de finalización
Difusión cultural científica y tecnológica	1	Se define en el momento de la apertura del curso	Atestado de frecuencia
Disciplina de cursos múltiples*	8	De acuerdo con el requisito previo definido en el curso	Certificado de estudio
Disciplina aislada	8	Se define en el momento de la apertura del curso	Certificado de estudio
Especialización (modalidad extensión)	360	Enseñanza superior completa	Certificado de finalización
Especialización técnica	360	Completado la escuela secundaria	Certificado de finalización
Extensión	30	Se define en el momento de la apertura del curso	Certificado de finalización

Nota *: el curso es simple cuando el curso y la disciplina forman una sola unidad; o múltiple, cuando está compuesto por dos disciplinas o más, pero es necesario que cada asignatura tenga carga horaria de por lo menos 8 horas. Fuente: adaptado del Informe de Actividades 2016 de Extecamp (2017, p. 11-12).

En 2016, Extecamp inició 353 cursos y asignaturas distribuidas de la siguiente forma: 11 cursos de perfeccionamiento; 80 cursos de especialización; 165 cursos de extensión; 82 cursos de difusión y 15 disciplinas aisladas, resultando en 29.875 matrículas (que fueron efectuadas por 10.038 alumnos). El número de matrículas realizadas en 2016 fue de 34.315 y el de estudiantes fue de 11.356, siendo que cada estudiante realizó, en promedio, los cursos que se iniciaron en el período anterior, el número de matrículas realizadas en 2016 fue de 34.315 y el de estudiantes fue de 11.356, 32 matrículas, a lo largo del año. El área con el mayor número de cursos y disciplinas propuestos en 2016 fue la de Ciencias Tecnológicas, representando el 31,9% del total (733), siendo que el número de cursos y disciplinas efectivos fue 448, o sea, 61,1% del total, total propuesto en el período. Esta área también presentó el mayor número de matrículas en el mismo

período totalizando 12,861, lo que representó el 37,5% del total. Otra área que se destacó en 2016 fue la de Ciencias Biomédicas, que respondió por el 73% del total de horas-lecciones impartidas, o sea, 91.447 horas-clase (de 125,312 horas-clase ministradas). El área con la mayor tasa de éxito en el ofrecimiento de cursos / disciplinas fue la de Ciencias Aplicadas, que propuso 138 cursos y disciplinas, de los cuales 114 se efectuaron (82,6%). Finalmente, con el objetivo de promover la ampliación del número de beneficiados con los conocimientos y experiencias de la Unicamp, también comúnmente se ofrecen cursos y disciplinas gratuitos. Para el cálculo de los números y porcentajes relativos a los cursos y disciplinas gratuitos se consideraron todas las modalidades de cursos, excepto las disciplinas de cursos múltiples. Por lo tanto, en 2016 se ofrecieron 84 cursos/ disciplinas gratuitas, lo que representó el 23,8% del total de cursos efectuados (533) por la Escuela de Extensión de la Unicamp en ese período. Estos cursos fueron frecuentados por 2,041 estudiantes, representando el 21,7% del total de estudiantes del período (9,412) (Extecamp, 2017b).

4.2.3 Dimensión compromiso social: servicios de salud

En vista de la amplitud de esta dimensión, que imposibilitaría la realización de una investigación minuciosa de las diversas actividades y prácticas desarrolladas en muchas de las 24 unidades de enseñanza e investigación de la Unicamp, así como todas las acciones de la Pro-Rectoría de Extensión y Asuntos Comunitarios (PREAC) de otras instancias de la universidad, optamos por la presentación de algunos indicadores del área de salud, especialmente los que involucra los servicios prestados a la comunidad.

El complejo de salud de la Unicamp está inserto en la Facultad de Ciencias Médicas (FCM) y está formado por los siguientes órganos: Hospital de Clínicas (HC); Hospital Estadual Sumaré (HES); Hospital de la Mujer "Profesor Doctor José Aristodemo Pinotti" - Centro de Atención Integral a la Salud de la Mujer (CAISM); y los servicios de apoyo (Hemocentro, Centro de Diagnóstico de Enfermedades del Aparato Digestivo - Gastrocentro, Centro de Estudios e Investigaciones en Rehabilitación "Prof. Dr. Gabriel O.S. Puerto" (CEPRE). El Hospital de Clínicas (HC) de la Unicamp es considerado uno de los más importantes hospitales universitarios del país, siendo que la actividad de enseñanza es una de las principales finalidades del hospital, pues los diversos procedimientos quirúrgicos, exámenes y las investigaciones realizadas proporcionan entrenamiento y etapa para alumnos de graduación, residentes y postgraduados en múltiples áreas de las Ciencias de la Salud y de otras profesiones relacionadas. En el HC se entrenan anualmente alrededor de 670 estudiantes de Medicina, 161 de Enfermería, 83 de Fonoaudiología y 40 de Farmacia. El HC también poseía el tercer mayor número de médicos residentes de Brasil (607), además de contar con aproximadamente 800 post graduados. El HC atiende a más de 100 municipios (lo que corresponde aproximadamente a 5 millones de personas), con una circulación diaria de más de 10 mil personas (https://www.hc.unicamp.br/node/178). La Tabla 4 presenta las cifras referentes a las actividades del complejo de salud de la Unicamp en 2016.

Tabla 4. Servicios de Salud realizados en 2016

Tipo de Servicio	Números
Lechos - hospitales	863
Trasplantes:	**351**
Cardíaco	8
Córnea	123
Hígado	47
Medula ósea	37
Riñón	136
Internaciones hospitalarias	38.166
Consultas atendidas	950.526
Intervenciones quirúrgicas	59.643
Nascimientos	5.129
Servicios de imagen*	355.098
Exámenes de laboratorio	6.344.551
Procedimientos odontológicos	148.110

Nota: incluye radiografía, ultrasonografía, resonancia magnética, radiología, ecografía y mamografía. Fuente: Anuario Estadístico 2016 (2017).

El Hospital de Clínicas (HC) es una referencia nacional en la formación y especialización de recursos humanos y también desempeña un papel destacado en el desarrollo de investigación y tecnología a través de investigaciones a nivel de iniciación científica, maestría, doctorado y postdoctorado, elaboración y desarrollo pruebas de nuevos tratamientos, medicamentos, prácticas quirúrgicas entre otros. De esta forma, "la efectiva prestación de servicios de asistencia a la población posibilita el constante perfeccionamiento de la atención, con la formulación de protocolos técnicos para las diversas patologías, lo que garantiza mejores estándares de eficiencia y eficacia, puestos a disposición para la Red del Sistema Único de Salud (SUS)" (https://www.hc.unicamp.br/node/71).

Los números y las informaciones presentadas permiten percibir el importante alcance de los servicios de salud prestados por la Unicamp a la comunidad. Sin embargo, como se observa, la prestación de estos servicios se convierte también en una valiosa oportunidad para que los estudiantes adquieran competencias específicas y mejoren las habilidades indispensables para el ejercicio de la profesión, constituyéndose en una vía de doble vía en la que la relación con la sociedad es una importante fuente de retroalimentación de las misiones enseñanza e investigación.

4.2.4 Percepciones y visiones de los entrevistados acerca de la relación universidad-sociedad: la realización de la tercera misión en la Unicamp

Como se describe en la sección de los procedimientos metodológicos, las 9 entrevistas se realizaron entre los meses de diciembre de 2015 y octubre de 2016 a partir de un itinerario compuesto por 17 preguntas abiertas, posibilitando al entrevistado flexibilidad y libertad para responder y explicar las razones de sus respuestas. En el caso de que se

trate de una de las más importantes para el logro de los objetivos propuestos para este artículo, es preferible la presentación de una síntesis de las entrevistas y elegimos sólo las 3 preguntas (Q.1, Q.2 y Q.3) de los entrevistados acerca de la realización de la tercera misión en la Unicamp. Es importante aclarar que las demás preguntas, aunque hayan sido relevantes para la investigación original (la tesis de doctorado), algunas de ellas se volvían a aspectos más genéricos o a cuestiones profesionales específicas (relacionados con las funciones de los entrevistados) o a temas más amplios involucrando el contexto nacional e internacional. En vista de ello, entendemos que la presentación en su totalidad extenderá excesivamente el artículo, haciendo la discusión excesivamente larga. Por lo tanto, a continuación, se exponen las preguntas y respuestas:

Q.1. ¿Como usted entiende la estructura de la Unicamp (Pro-Rectoría de Extensión y Asuntos Comunitarios, Escuela de Extensión, Fundación de Desarrollo de la Unicamp, Agencia de Innovación y otras) direccionada a la relación Universidad-Sociedad? *¿Es adecuada? ¿Está muy descentralizada? ¿Hay superposiciones? ¿Que está faltando? ¿Qué sería lo más adecuado?*

Según la mayoría de los entrevistados (8), entendió y consideró adecuada la actual estructura universitaria (instancias) para la realización de la relación universidad-sociedad. Sin embargo, incluso considerando la estructura adecuada, se señalaron algunos obstáculos / obstáculos al desarrollo y consolidación de la relación de la universidad con la sociedad (falta de diálogo, comunicación e interacción entre las instancias fueron los más señalados). Sólo 1 entrevistado entendió que la estructura debería ser más centralizada, pues la centralización podría hacer las acciones más cohesionadas, facilitar la comunicación, la alineación de intereses y las interacciones. Por centralización se presume que todas las acciones dirigidas a la sociedad deberían ser colocadas bajo la tutela de la Pro-Rectoría de Extensión, indepentemente del público objetivo (empresas, organizaciones sin fines de lucro, comunidad en general, gobierno, entre otros).

Q.2. ¿Qué cambios sugeriría en la forma en que la Unicamp conduce sus actividades de interacción con la Sociedad? ¿Por qué y cuáles?

Todos los entrevistados realizaron alguna (o muchas) sugerencias, en diversos campos, tales como: crear y/o mejorar los canales de comunicación internos y externos; interconectar las instancias y promover sinergias; profundizar el nivel de conocimiento y perfeccionar las concepciones vigentes acerca de la tercera misión, adoptando una visión holística; reconocimiento y valorización del docente en las actividades de extensión universitaria; crear metodologías de evaluación; crear una cultura de la tercera misión; desarrollar y perfeccionar las formas de gobernanza; la legitimación de la universidad frente a la sociedad (difundir, informar, demostrar la relevancia de su actuación - de las investigaciones que realiza, de la enseñanza, etc.).

Q.3. ¿Cuáles son las principales dificultades para el desarrollo de la relación universidad-sociedad?

Fueron muchas las dificultades (obstáculos, desafíos, como prefirieron llamar algunos entrevistados) apuntados. Algunos de los entrevistados afirmaron que la universidad sigue siendo una "torre de marfil" y se presenta de forma muy arrogante ante la sociedad. La falta de incentivo al docente también fue considerada un obstáculo (los incentivos, la valorización, el reflejo en la carrera docente ocurre, por regla general, a partir de las actividades de enseñanza e investigación - publicaciones); preconcepto respecto de la realización de actividades de protección de las tecnologías generadas y de la transferencia de tecnología; preconcepto respecto de ciertas relaciones, por ejemplo, con el sector productivo; visiones estrechas y limitadas de la extensión universitaria - todavía existen en las universidades (públicas) visiones fuertemente asistencialistas; la sociedad/comunidad/el público en general desconoce todas las realidades de la contribución de la universidad (luego, es necesario si "mostrar", divulgar, difundir lo que se hace); carencia de recursos financieros; visión estrecha de la relación universidad-sociedad (necesidad de una visión más amplia).

5. Conclusiones

Los resultados permitieron concluir que la Unicamp se destaca en la conducción de varias iniciativas de la tercera misión, en diversos campos, pasando por la excelencia en el área de salud y de los servicios ofrecidos a la población, al gran número de cursos ofrecidos por la Escuela de Extensión (Extecamp), a las acciones de la Pro-Rectoría de Extensión y Asuntos Comunitarios (PREAC) volcadas a la extensión comunitaria. Además, la actuación de Inova ha posibilitado que la Unicamp desempeñe un papel destacado en el escenario nacional como una de las universidades más activas en el campo de la protección a la propiedad intelectual, licencias, incubación de empresas, gestión del parque tecnológico, entre otras importantes acciones.

Sin embargo, aunque las estructuras e instancias de soporte a tales acciones están bien consolidadas, se nota la falta de interacciones más fuertes entre ellas, no en el sentido de una estructura única y centralizadora para albergar tales acciones, sino en lo que se refiere al establecimiento de directrices que refuercen iniciativas conjuntas y promuevan sinergias. La tercera misión es compleja, multifacética, pues son innumerables las posibilidades de realización, y hay mucho aún por ser pensado. Son muchos los puntos de contacto que pueden ser trabajados, tales como, mejorar los canales de comunicación, fomentar el diálogo e intercambio de informaciones, estimular y desarrollar iniciativas conjuntas entre las diferentes instancias, entre otros.

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A leadership competency model of science and technology parks: the case of *Chungbuk* Techno Park in Korea

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Abstract: Given their significant regional economic benefits, science and technology parks (STPs) have attracted continuous academic attention. To understand the predictors of performance of STPs, this study focuses on the critical impacts of leaders and develops a leadership competency model specialized for public STP leaders. The competency model identifies the qualities and conditions of an effective leader of public STPs, emphasizing management skills, bottom-up approach, and boundary spanning skills. To provide empirical support, this study adopts the case study approach and performs a behavior event interview with one of the most successful leaders of public STPs in Korea.

Keywords: leadership; competency model; boundary spanning; incubator

Submitted: July 5th, 2018 / Approved: November 22nd, 2018

Introduction

Because the formation of new technology-based firms is a critical driver of economic growth, governments in many industrialized economies have actively engaged in developing science and technology parks (STPs) to assist in the growth of firms and the regional economy. Recognizing their significant potential, researchers have paid continuous attention to the functions and operations of STPs. The most frequent goals of existing studies have been to understand the effects of STPs on the performance of venture firms (Yang, Motohashi, & Chen, 2009; Fukugawa, 2006; Westhead & Batstone, 1998; Westhead, 1997), the formation of innovation networks between industry and university in the parks (Link & Scott, 2003; Vedovello, 1997), and the contributions to regional and national economic growth (Hu, 2007; Sternberg, 2004). Despite the diverse research approaches, the critical research question that has yet to be sufficiently explored is what distinguishes successful STPs from the less successful ones and what are the critical factors that explain the variable performance of STP organizations. Despite increasing policy concerns over how to measure the performance of a STP (Albahari, Catalano, & Landoni, 2013; Bigliardi, Dormio, Nosella, & G. Petroni, 2006), few studies have made notable contributions to identifying their critical performance factors and empirically examining their effects.

With the goal of addressing the limitations of the existing literature, this study considers the leaders of STPs as critical to explaining their organizational performance and focuses on examining the qualities and conditions of successful STP leaders. In any organization, effective leadership has a significant effect on performance because it provides a sense of direction and vision in accordance with environmental changes, facilitates organizational cohesiveness, personal development, and high employee satisfaction, and implements a healthy mechanism to promote innovation and creativity (Thach & Thompson, 2006; Hollenbeck et al., 2006; Carmeli & Tishler, 2006; Hannon, 2005; Wart, 2003). Effective leaders are a critical resource for organizational success because they significantly influence strategic decisions and their implementation (Carmeli & Tishler, 2006). Thus, an urgent issue in an STP study is to identify the critical qualities and competences of leaders in explaining organizational performance and long-term success.

By focusing on the qualities of successful STP leaders, this study proposes a competence model tailored for public STP organizations. A competency is a measurable human capability that affects the performance of a certain job, and a competency model is the set of knowledge, skills, and personal characteristics required to achieve high performance in a job (Campion, Fink, Ruggeberg, Carr, Phillips, & Odman. 2011; Hollenbeck et al., 2006; Marrelli et al., 2005; Lucia & Lepsinger, 1999; McClelland, 1998; McClelland, 1973). Since the seminal study of McClelland (1973), competency modeling has expanded broadly into a variety of fields and disciplines, including leaders' competency for creativity and innovation (Halbesleben, Novicevic, Harvey, & Buckley 2003), project managers (Müller & Turner, 2010), the hospitality sector (Testa & Sipe, 2012), health care professionals (Marrelli et al., 2005), medical education (Talbot, 2004), and even a specific firm, such as 3M (Alldredge & Nilan, 2000). In particular, as a competency model specialized for organizational leaders, leadership competency modeling identifies the specific competencies required to enhance leadership effectiveness (Thach & Thompson, 2007; Hollenbeck, McCall, & Silzer 2006; Hood & Lodge, 2004; Halbesleben et al., 2003). By proposing a map of the core qualities of effective leaders, a leadership competency model can guide the critical HRM process of selecting, evaluating, and training and developing leaders.

This study makes an attempt to construct a leadership competency model tailored for STPs by focusing on the management skills, bottom-up approach, and boundary spanning skills. Public STPs, funded by regional or national governments, play a crucial role in providing business support to new technology-based firms and nurturing regional and national economic growth. STP leaders can have

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ISSN: 0718-2724. (http://jotmi.org)

detrimental effects on operational performance because they are in charge of formulating long-term organizational visions and strategies, designing effective organizational structures, implanting systemic human resource management (HRM), and forming extensive external networks with critical stakeholders.

STP Leadership Competency Model

Management Skills

Management skills comprise a significant part of the leadership competency of STPs because many public organizations suffer from problems associated with formal bureaucracies (Walker et al., 2011; Denhardt & Denhardt, 2000). With respect to the operation of public organizations, a longstanding critique has been bureaucratic inefficiency caused by waste, delay, and unresponsiveness in organizational operations. The management skills of public STPs represent the ability to efficiently use the organization's resources and to make effective decisions regarding planning, organizing, staffing, and controlling incubator operations to achieve higher performance (Carmeli & Tishler, 2006; Hannon, 2005; Lalkaka, 1996). Management skills of leaders in public STPs indicate the organization's clear strategic vision and its valid plans to achieve its goals. The leader's managerial skills include a variety of abilities, such as persuasiveness, administrative ability, knowledge about group skills, and social skills (Carmeli & Tishler, 2006), which have strong implications for organizational performance.

The role of the STP leader is to organize and direct all of an organization's activities by making strategic and operation decisions that are highly significant to its performance and success. The essential planning issue that an effective leader of STPs should address is to select a sub-sectorial niche on which organizational efforts should focus (Lalkaka, 1996). Furthermore, management skills enable STP leaders to design efficient work structures and enable organizations to make the best of precious resources while preventing irresponsible waste in public spending. The organizing capability of the leader resides in the effective structuring of resources and activities to provide counseling services, mobilize funding opportunities, and facilitate external networking to nurture the growth of venture firms. The HRM capability of the STP leader is to secure competent personnel, design systemic compensation and evaluation schemes that provide quality services and support to tenants, and enhance organizational commitment. Finally, controlling an effective leader includes designing valid performance measurements to evaluate the quality of incubating services and the efficiency of personnel, and to correct deviations from the operational standards to assure STP performance.

Bottom-up approach

In the studies of policy making and implementation, the bottom-up approach is a strategic process that captures the policy ideas and information of the actors in the focal impact domain and collaborates with the actors in order to reflect their ideas into the higher process of making policies (Ossenbrink, 2018; Koontz & Newig, 2014; Sabatier, 1986). Although the top-down approach of policy making starts with a policy decision made by governmental entities (Sabatier, 1986) and emphasizes a strategic intent that the policy pursues to achieve (Ossenbrink, 2018), the bottom-up approach captures the ideas from the actors and entities in the target domain of the focal policy. Rather than assuming that policy makers can directly control implementation in the lines of top-down authority, the bottom-up approach presumes that policy makers can make better decision when they understand what resources are necessary for the work performance and how the task may affect the behaviors of the policy target (Koontz & Newig, 2014).

Taking an inductive perspective, the bottom-up approach adopts a lens for drawing a broad spectrum of policy ideas from a variety of governance levels, entities, and policy fields, moving them to the top policy-makers in both the public and private sectors (Ossenbrink, 2018; Koontz & Newig, 2014; Sabatier, 1986). Bottom-up approach captures information provided by the actors who are in the impact domain of the policy, such as firms and individuals who are in the position of driving innovation in a particular sector (Ossenbrink, 2018). The approach uses a networking technique to identify the entities actually involved in planning, financing, and executing the relevant policy program (Sabatier, 1986). As the actors struggle in the impact domain of innovation policy, they have a vested interest in knowing the policy influences and outcomes and their interpretations of policy signal could have significant implications to the successful implementation of a focal policy (Ossenbrink, 2018). As the actors perceive problems in the field and try to develop the strategies to deal with them, they are able to evaluate the relative importance of a variety of governmental programs and policy measures in solving those problems (Sabatier, 1986).

The bottom-up approach constitutes a core competency of leaders in public STPs as it enables them to align assistance strategy with the needs of tenants. The significant aspect of bottom-up approach that the successful STP leaders should have is networking with tenants firms to gain the ideas and information to develop the assistance and supports tailored to the actual needs of the tenants firms. The effective portfolio of STP's assistance services is to devise the customized supports that could meet the real needs of individual firms while preventing the potential waste and loss in public spending (Lalkaka, 1996). Tenants' needs for managerial resources and counseling services are diverse with respect to industry sectors, technologies, and growth stages (Vanderstraeten & Matthyssens, 2012; Rice, 2002) and the bottom-up approach could signify the value of customization in the incubating process. The bottom-up approach of STP leaders facilitates capturing the ideas and information from the tenants and help designing the effective assistance and counseling to leverage actual business growth and the development of venture firms. The irrelevant services not only prevent the optimal use of valuable resources but also raise the problems of fiscal loss and waste in public spending for which bureaucratic organizations are often criticized. Thus, the bottom-up approach of STP leaders facilitates developing highly needed business support to fortify the concrete growth of tenant firms while maximizing the accountability of public spending.

Boundary Spanning Skills

One of the most important roles played by effective STPs is to act as an intermediary between the tenant and regional firms and external resource providers. Effective organizational leadership is actualized when an organization collaborates across boundaries to achieve goals that it has in common with others (Takanashi & Lee; 2018; Ernst & Chrobot-Mason, 2011). A significant aspect of high-performing leaders is the ability to form large diversified collaborations with external organizations. Boundary spanning leadership is the ability to create a common direction, alignment, and commitment across group boundaries to achieve a higher goal (Ernst & Chrobot-Mason, 2011). Conceptualized in innovation studies, boundary spanning refers to promoting information flows across the boundaries of different organizations to accelerate the absorption, sharing, and transmission of information, thus significantly contributing to organizational performance and innovations (Lee, 2014; Lee, Ohta, & Kakehi, 2010; Tushman & Scanlan, 1981; Aldrich & Herker, 1977). Boundary spanning leadership enables organizations to achieve results together that go beyond the achievements of a single organization (Ernst & Chrobot-Mason, 2011).

The boundary spanning leadership of STPs helps expand connections and collaboration with external stakeholders who provide these parks with resources critical for survival and growth. STPs' external networks facilitate tenants' access to external resources, such as counseling and mentoring, R&D grants, human capital, marketing and distribution, venture capital, and government grants and loans. Through mediation, STPs can increase the visibility, credibility, and understandability of tenant firms in the eyes of external investors (Bergek & Norman, 2008). Through effective boundary spanning, an incubator leader can establish institutionalized networks that allow tenants to gain access to external resources beyond the personal social capital or connections available to a few people (Bøllingtoft & Ulhøi, 2005). The boundary spanning capability of incubator leaders achieves higher incubating performance by providing venture firms with external networks to mobilize critical resources.

Methodology

Our empirical analysis adopts the case study of a successful leader on the basis of the behavior event interview (BEI). The BEI is a unique interview methodology highly relevant for the competency modeling process (Campion et al., 2011; Marrelli, Tondora, & Hoge 2005; McClelland, 1998). In the BEI, top performers are interviewed individually to gain information about what they did, thought, intended, and felt in changing situations or when coping with difficult problems (Marrelli et al., 2005). It is a highly in-depth interviewing process aimed at collecting detailed information on past situations on the job and understanding the ideas and intentions behind the actions (Campion et al., 2011; McClelland, 1998). A BEI is used to identify and select relevant informants to collect empirical evidence supporting the theoretical model. Selecting STPs for the case analysis in this study proceeded through following screening processes.

First, we used open resources to collect basic demographic data on all of the formal and incumbent directors of eighteen STPs. An investigation into the directors of STPs formed a list of 79 directors who served from 1997 to 2015, which included basic information on name, age, gender, academic background, work experience, and major achievements during a four-year tenure term.

Second, we formed an initial pool of outstanding leaders in question by pursuing recommendations from the incumbent and former chairman of the Korea Techno Park Association, the trade association comprised of directors of eighteen STPs. Because the association holds regular directors' meetings and discussions to address the managerial and policy issues of STPs, the chairman is believed to provide highly relevant information regarding the directors who exercised outstanding leadership and achieved excellent performance. The inquiry provided a pool of three directors with good reputations and outstanding performance records. On the basis of the recommendation, we investigated the achievement and performance evaluations of leaders done by the Korea Institute for Advancement of Technology (KIAT). As the founder and governing agency of STPs, the KIAT performs annual assessments of STPs' management and operational performance. All three directors won the Best-Performance Prize multiple times during their terms. Furthermore, all recommended leaders were reappointed after successfully completing their first service term. In general, the tenure of an STP director is four years, and all leaders are reappointed through recognition of good performance.

Third, the final selection of the leader for the case study was based on the cooperative responses from the informant and favorable access to the research data and internal cooperation, which led to the selection of the N-Director of Chungbuk TP located in the Chungcheongbuk-do Province. To engage in an in-depth analysis of the leadership competency of the N-Director, this research conducted an extensive search of the open data and visiting interviews to supplement the second-hand information. Investigation of the open data relied on a newspaper portal service provided by the Korea Press Foundation. The web service allows articles in most newspapers and magazines published in Korea to be searched, and the search generated more than 500 related articles. The news articles revealed detailed information on operational activities, service programs, external alliances, and the achievements of the leaders because the STPs actively disseminate information for public relations purposes.

Fourth, after analyzing the major events of Chungbuk TP, we conducted four structured and semi-structured interviews with not only the N-Director but also team managers (see the Appendix). The interview questions were designed to ask why and how the N-Director initiated organizational changes, adopted new programs, and formed external alliances, and what the leader thought, intended, and felt when initiating organizational changes and introducing new policies. Furthermore, to complement the focused interviews, four interviews with managers and researchers in three other STPs (Chungnam TP, Daejeon TP, and Gwangju TP) were conducted to validate the theoretical insights in different STP contexts and to infer the unexplored dimensions of the role and effect of successful STP leaders (See Appendix).

Case study of N-Director in Chungbuk Techno Park

Chungbuk TP, which is the focus of this study, was sponsored by the Ministry of Trade, Industry and Energy (MTIE) in 2003, and it consists of two units and three centers, such as Policy Planning Unit, Incubating Unit, Next Generation Semiconductor Center, IT Convergence Center, and Bio Center. Similar to numerous other STPs, the initial phase of development focused on the construction of physical infrastructure to provide space for tenant firms and R&D centers (KISTEP, 2012). Since 2008, the strategic focus has changed to promoting innovations in four strategic industries in the region, such as biotechnologies, semiconductors, electricity and electronics components, and next-generation batteries. The N-Director was inaugurated in October 2010 as the third director of the organization. Since taking leadership of the park, the N-Director has archived outstanding performance. With respect to external evaluations, the Chungbuk TP won the Best-Performance Prize in 2011, 2012, and 2014 in the KIAT Annual Techno Park Management Performance Evaluation. Regarding the performance of incubating activities, the number of tenant firms increased from 52 in 2008 to 88 in 2013, the number of employees in tenant firms, from 758 in 2008 to 2,941 in 2013, and the revenue of firms, from US$0.37 billion to US$1.25 billion during the same period.

Management Skills

After the inauguration in 2010, the N-Director took the initiative to select strategic industries that the STP would support from a long-term perspective. Simultaneously, the N-Director actively engaged in reforming the organizational structure and HRM systems to effectively foster growth in the strategic industrial sectors. To select the strategic industries, the N-Director formulated basic guidelines to review the emergence of new industries and investigated regional market needs. Furthermore, the more significant concern that the incoming director should address urgently was the organizational rigidity and low employee morale. Although the STP organization has grown consistently since its inception in 2003, it has suffered from the organizational problems prevalent in many bureaucratic, public organizations. Similar to many other public organizations in Korea, the Chungbuk TP offered strong job security as a public organization, seniority-based wages and promotion, and a strict hierarchy in the decision-making process. All of these issues caused low organizational vitality, strong sectionalism of individual units, and low employee work motivation.

The underlying guideline that the N-Director adopted to reform the public organization was fitting its organizational structure and necessary functions to the new strategic goals of the organization. In a reform effort, the N-Director eliminated functional duplication between different organizational units and centers. Because different ministries of the central government funded the establishment of internal units and centers (Oh & Lee, 2013), they indicated strong sectionalism and wasteful duplication of similar functions. As an illustration, large operational and functional overlaps existed between the Semiconductor Center and the Embedded Semiconductor Center and between the Traditional Pharmaceutical Center and the Healthcare Medical Center. The reform initiative integrated them into the next-generation Semiconductor Center and the Bio Center, respectively.

In addition to fitting the organizational structure to the strategies, the N-Director reformed the HRM systems, which exerted a strong influence on employee motivation and the control of work behavior. The N-Director's basic belief is to build a work environment in which managers and employees are motivated to proactively perform their work.

"Leader should consider how to build harmony among organizational members, vertically as well as horizontally, and how to lead them to achievement of strategic goals. To do this, I believe, I should create a work environment in which all the organizational members work proactively rather than passively" (Interview with N-Director, 2015). First, with the goal of vitalizing the organization, the N-Director adopted an open competition rule in which employees jockeyed for managerial positions of teams or units. The traditional seniority-based wages and promotions had restricted healthy competition among employees, which resulted into low motivation and passive work attitudes. The open competition rule aroused healthy tension among the senior employees by creating strong performance pressure. The senior employees should achieve high work performance to be promoted to a managerial position. Furthermore, they faced the continuous competitive pressure of losing the position when they failed to meet the expected performance results.

Second, the N-Director adopted the empowerment rule for junior employees in planning and granting project funds. This rule delegated full authority to outstanding junior employees to propose and plan a funding project, even if relatively small. By endowing project leadership opportunities to junior employees, the rule assisted in both motivating young employees to actively pursue funding chances and achieve high performance and creating strong competitive pressure on the unit and team managers, leading to the formation of proactive work attitudes in general.

Third, to break down the traditional sectionalism among internal units, the N-Director introduced a job rotation policy in which employees changed their jobs regularly by moving to different functional units and teams. Because the individual units and centers were funded by different agencies of the central government, they pursued independence and autonomy and exhibited strong isolation and duplication in their work operations. As a solution to the problems, the job rotation provided crucial opportunities to understand the work and roles of different units. The job rotation promoted a mutual understanding between employees of different functions and formed inter-personal and inter-unit cohesion.

Along with the aforementioned "stick" policies, the N-Director also adopted "carrot" policies to foster work motivation and employee morale. One of the most significant reforms was to increase the level of employee wages to that of central government officials. Because

the STP represented a newly established regional organization, its wages and fringe benefits were set at much lower levels than that of the central government, which significantly demotivated employees. Through continuous petitions and negotiations with the governing agency, the N-Director increased employees' basic pay to the pay levels of public officials in the central government, strongly increasing employee morale. Furthermore, to foster organizational membership and loyalty, the N-Director actively supported the formation of employee social clubs and cultural events and provided various fringe benefits in accordance with organizational performance.

Bottom-up approach

The bottom-up approach in the operation of STP is to capturing the ideas and information from the tenant firms and individuals and reflects them to designing of the policy and strategy of business assistance services. An ultimate goal of STPs is to provide supportive services to nurture the development of innovative firms in the region's strategic industries. A distinguishing aspect of the N-Director's leadership was to capture ideas and information regarding the actual needs of venture firms. Such knowledge and insights have been reflected into the STP's policy and strategy for developing the supportive consultation programs. Furthermore, the bottom-up approach helps not only building networks with venture firms, but also identifying creative R&D ideas that could gain governmental research funds.

One way to foster the growth of tenant firms and regional strategic industries as initiated by the N-Director is to identify venture firms' creative "seed" ideas and develop them into full-fledged R&D projects sponsored by external funding agencies. The nurturing process starts with a regular meeting with venture firms to identify R&D needs and creative ideas. Direct discussions with the firms often lead to identifying breakthrough ideas that have strong potential for technological innovations and new business opportunities. After developing a pool of potential ideas, the nurturing process undergoes a screening procedure in which professionals and experts in the related technological fields set the project development priority. The selected ideas were refined and modified into formal proposals to be submitted to governmental funding agencies.

Another way to facilitate the growth of venture firms is to develop incubating programs tailored to the individual needs of firms that are the ultimate beneficiary of the services. Developing supporting services started with prior investigations of tenant needs, which were reflected in the customized design of supporting programs. The N-Director's bottom-up approach in the development of business assistance originated from the belief that, as the service needs of tenant firms have become more specific and complicated, achieving tenants' satisfaction required a more proactively designed support system. A prior study on firms' needs helps to reorient the development of support services from the point of view of tenant firms and proposes different combinations of support in accordance with the firm's growth stage and industrial differences.

As an illustration, the customization efforts of support services have led to fortifying the Contact Center, which is a specialized incubating service center based on a membership system. The characteristic aspect of the center was to combine a variety of supporting services provided by different organizations, such as governmental agencies, public R&D institutes, and private enterprises, into a "one-stop service package." The packaged services are tailored to venture firms' individual needs, and the specific services include supporting the formulation of business strategies, identifying proper public funding agencies, writing funding proposals, and accessing external supporters. As the first component of the packaged program, technology consulting diagnoses problems at every stage of corporate growth and sends experts from various technological fields who can provide appropriate solutions to the identified problems. Without the customized program, a frequently raised problem is that incubatee firms should pursue different services from individual agencies, thus utilizing substantial time and effort in gaining less helpful support.

Boundary Spanning Skills

Some of the most significant resource providers of STPs in Korea are the ministries and agencies of the central government; in particular, a large R&D fund typically comes from the central government (Oh & Lee, 2013). Thus, the N-Director's extensive networking with funding ministries has enabled the Chungbuk TP to achieve two-way communications, both top-down and bottom-up, and to coordinate the policy directions of key stakeholders, such as the central government, the regional governments, and local industries. On the one hand, extensive networks with public officials in ministries offer access to critical information on the basic direction and goals of R&D funding policies adopted by individual ministries. To receive large grants, STPs' proposals should be developed in line with the basic directions of policy programs.

"If we can get some tips from the central government, we can write the proposal in accordance with the goals and direction of the funding agency. It increases the possibility of granting a large fund. It is like a rush into battleground. I directly visit the key persons who know the real goals of research funding programs and expand communication with them" (Interview with N-Director, 2015).

On the other hand, leaders' close networks with funding ministries are critical channels through which the STP could appeal to funding agencies regarding its regional needs. Thus, a critical role of the N-Director is to effectively deliver the needs and ideas of local industries. Because government funds in Korea have strict regulations regarding where and how they are spent, failing to reflect the local needs in the funding plan could result in an ill-designed and less useful grant.

"We have deeper knowledge about local characteristics and specific-needs in this region than central government as we make the regional promotion plans and implement them. To bring funds tailored for local situations, I need to meet them again and again. I have to prepare the well-made story lines to justify why some types of aid are needed especially for this region" (Interview with the N-Director, 2015).

In addition to the central government, the critical role of STP leaders is to develop close collaborations with public research institutes,

regional universities, and business enterprises in strategic industry sectors to form a regional innovation cluster. On the basis of the belief that close connections between public and private institutions can promote technology transfers, the N-Director has actively engaged in building alliances that help tenant and regional firms gain access to external technologies and resources. The N-Director offered collaboration plans to strategic firms by continuously touting the benefits of establishing business entities in the regional cluster, including support of public R&D institutes and subsidies from the regional government.

"We should endlessly send out signal that you can make money here. We know what business the company is engaged in, who is the key person, and how to entice them to move into this region. I know how to give them necessary carrots to bring it in" (Interview with the N-Director, 2015).

One of the most representative networking programs that the N-Director organized was the "Global Commercialization Networking Program for the Pharmaceuticals–Bio in Chungchung Areas," which was a university-industry-government (UIG) consortium sponsored by the Ministry of Knowledge and Economy (currently, the Ministry of Science, ICT, and Future Planning) in 2011. With the goal of constructing a regional innovation cluster in the pharmaceutical and biotech industry, the Chungbuk TP took the initiative of organizing the UIG consortium and attracted total investments of US$144.4 million from the public and private sectors. By playing a catalytic role in forming collaborative innovation networks in the region, the UIG consortium enticed a variety of innovation entities, such as universities, governmental research institutes, large established firms, and small venture firms.

A notable aspect of the consortium was the establishment of a contract manufacturing organization (CMO) by LG Life Sciences, one of the largest producers and R&D investors in Korea. In the pharmaceutical industry, the CMO is a specialized service provider that offers outsourcing services to client firms in the long value chain of activities, from drug development through manufacturing to distribution. Because of the inherent complexity and enormous costs of R&D and commercial production related to drugs, many pharmaceutical firms are highly specialized in certain value-chain activities, and outsourcing to a CMO helps firms save substantial upfront capital investments for drug development. By implementing a critical infrastructure for developing a pharmaceutical innovation cluster, LG Life Sciences' CMO service could assist in forming new venture firms specialized in R&D and in accelerating the commercialization of their research achievements.

Discussion and Conclusion

Given the significant economic contributions that successful STPs can make at both the regional and national levels, this study pursued the elucidation of the critical factors that predict the diverging performance results of STPs. To fill the void in the existing STP literature, this study focused on leadership competency as a critical factor of STP performance. By examining the critical qualities and conditions of successful STP leaders, it proposed a competence model tailored for STP leaders and provided empirical support to the model on the basis of an in-depth case study of the N-Director of Chungbuk TP in Korea. The leadership competency model in this study suggested the following competences as essential qualities of successful of STP leaders.

First, management skills of STP leaders help design and implement effective management systems that formulate the strategic planning of STP activities, construct effective organizational structures to carry out the plans, and motivate employees to achieve organizational objectives. A core aspect of the management skills of public STP leaders is to align the organizational structure with the strategic direction. Leaders' managerial competency establishes effective rules that guide and govern the organization's operations and activities in such a way that the strategic objectives are achieved. In particular, the case analysis of this study suggests that management skills are highly relevant to a public organization because such skills can minimize the operational inefficiencies and organizational rigidities from which bureaucratic public organizations often suffer. A chronic concern is that public organizations are plagued with bureaucratic rules, organizational rigidities, and excessive controls. The research results indicate that the critical part of HRM in public STPs is infusing healthy tension and competition among employees who tend to lose their enthusiasm for work under strong job security and excessive bureaucratic control.

Second, the bottom-up approach constitutes the key competency of successful STP leaders because it enables STPs to develop supportive services tailored to meet the actual needs of tenant firms. According to the case study, the bottom-up approach of an effective leader manifests itself in the differentiation and specialization of support services which reflects the ideas and information collected from the tenant firms and the assistance services are tailored in accordance with the growth stages and industrial differences of venture firms. By adopting a tenant's point of view, the tailored support services enhances the usability of STP services for the recipient firms, which not only enhances the effectiveness of the incubator activities but also guarantees higher accountability of public expenditures. The bottom-up approach enables STP leaders to identify highly prospective ideas of venture firms and nurture them to grow into full-fledged projects sponsored by government funding agencies. The bottom-up approach can enhance the commercial results of innovative ideas because it allows for proactive incubation support of innovative technological potential.

Third, the boundary spanning skills of STP leaders facilitate building extensive external networks through which venture firms gain access to critical resources. As a key competence of the organizational leader, boundary spanning skills enable STPs to foster cooperation with external resource providers. They help bridge different goals and interests when identifying common benefits that organizations can collectively pursue. The case analysis of this study shows that the boundary spanning activities of STP leaders involve not only identifying key information regarding the goals and directions of the government but also foster communication with government agencies to ensure that they reflect region-specific needs through the policy-making process.

The boundary spanning skills of a leader facilitate communication with external stakeholders, coordinate strategic directions with them, and draw on common interests. These skills provide venture firms with critical external networks that enhance the accessibility to external support. Furthermore, the seamlessly organized external networks of STPs facilitate designing integrative services to effectively meet the specific needs of venture firms.

The critical benefits of leadership competency modeling is to provide HRM practitioners with ultimate guidelines for recruiting, screening, training, assessing, and rewarding critical human resources. Although STPs have different leader selection rules and processes, the competency model proposed in this study serves as the basic criteria for clarifying the essential leadership qualities required for leaders to achieve high organizational performance. Despite critical leaders' effects on the STP organization, few studies have suggested the necessary conditions for the specialized education and performance assessment of STP leaders. The research results of this study help policy makers propose effective educational programs and systemic appraisals tailored to public STP leaders. In turn, for potential STP leaders, the competency model informs them of the necessary skills, knowledge, and attitudes that public STP leaders should acquire and develop to achieve a successful career.

Although this study has made the first attempt at developing a leadership competency model specialized for public STPs, the model should be complemented by further studies to improve its theoretical validity and practical usability. First, this study focused on only a few competences out of the numerous necessary qualities and attitudes that effective STP leaders should have. A more refined approach to the competency modeling process should provide further considerations for the roles and effects of personal attitudes and characteristics. Critical individual traits, as a fundamental part of competence (Campion et al., 2011), may include self-management, proactiveness, professionalism, social skills, communication, and emotional skills because they create an essential personality basis to effectively activate the functional competences discussed in this study. Second, another critical direction of future research is to investigate interactive and correlation effects between different competences proposed in the model. The competences may complement one another, and a different set of competences can lead to higher effectiveness and better performance than others. Thus, examining interactions can assist in designing an optimal competency model that provides more effective guidance for the selection, development, and evaluation of leader competency. Third and finally, the limitation of this study is that the leadership competency model was based on the case study of a single STP leader in Korea. Thus, future research that adopts a quantitative methodology in a variety of national contexts will provide more rigorous evidence to prove the model's validity and applicability.

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Appendix 1. Interview Record

Date	Techno Park (TP)	Family Name and Initials	Rank and Function
July 2015	Chungbuk TP	J. S., Park	Manager of Management Planning Team
August 2015	Chungbuk TP	J. S., Park	Manager of Management Planning Team
August 2015	Chungbuk TP	S. K., Min	Manager of Management Planning Team
August 2015	Chungnam TP	S. J., Yang	Manager of Policy Planning Team
August 2015	Chungnam TP	N. K., Song	Researcher in Policy Planning Team
August 2015	Daejeon TP	J. M., Whang	Researcher in Regional Industry Support Team
August 2015	Gwangju TP	A.Y., Oh	Researcher in Regional Industry Support Team
November 2015	Chungbuk TP	C. H., Nam	Director of Techno Park
November 2015	Chungbuk TP	S. W., Kwon	Manager of Industry Planning Team