IBJESB | IBEROAMERICAN JOURNAL OF ENTREPRENEURSHIP AND SMALL BUSINESS
REVISTA DE EMPREENDEDORISMO E GESTÃO DE PEQUENAS EMPRESAS

PUBLISHER ANEGEPE

e-ISSN: 2316-2058 v.11, n.3, Sept./Dec., 2022 www.ibjesb.org

Research Article

Performance of Brazilian spin-offs and startups: A study on technological evolution based on entrepreneurship and networks

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Open access

Check for updates

Editorial details

Double-blind review System

Article History
Received : *Mar. 22, 2021*
Reviewed : *Apr. 04, 2022*
Accepted : *Aug. 31, 2022*
Available online : *Nov. 17, 2022*

JEL Code: *O30, O32*

Article ID: *2103*

Editor-in-Chief[1] or Adjunct[2]:
[1] Dr. Edmundo Inácio Júnior
Universidade Estadual de Campinas, UNICAMP

Handling Editor:
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Executive[1] or Assistant[2] Editor:
[2] M. BA. João Paulo Moreira Silva

Translation / Proofreading:
Dra. Eva Stal

Funding:
CAPES, #001

Cite as:
Buarque, B.; Câmara, S. F.; Fischer, B. B.; Magalhães, R. C. (2022). Performance of Brazilian spin-offs and startups: A study on technological evolution based on entrepreneurship and networks. Iberoamerican Journal of Entrepreneurship and Small Business, 11(3), Article e2103. https://doi.org/10.14211/ibjesb.e2103

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Abstract

Objective: to understand the relationships in advance of technological maturity and organizational performance in academic spin-offs and Brazilian startups. **Method:** quantitative research, with the application of 62 questionnaires, 17 of which were used as a pre-test. **Originality/Relevance:** this paper develops an approach oriented towards knowledge-intensive entrepreneurship in the context of a developing country, using data obtained from academic spin-offs and startups, based on an original model that relates the studied constructs. **Results:** empirical results made it possible to highlight the importance of Entrepreneurial Orientation as an antecedent of both Knowledge Conversion Capacity and Network Capacity. **Theoretical/methodological contributions:** aspects related to Entrepreneurial Orientation, Knowledge Conversion Capacity, Network Capacity and Technological Maturity were articulated in a conceptual model with a view to ultimately identifying the determinant mechanisms of Organizational Performance. **Social/Management Contributions:** the findings underscore the role of the ecosystem as a critical meta-structure for entrepreneurial development. This is because the components of the Entrepreneurial Orientation at the firm level are intrinsically connected with the diffusion of a culture of entrepreneurship in the agents. Additionally, both the Knowledge Conversion Capacity and the Network Capacity encompass the dynamics of interactions and knowledge flows between the firm and agents with complementary capacities. Thus, the results of this research underscore the need to develop a systemic orientation for understanding new knowledge-intensive entrepreneurship.

Keywords: Knowledge-intensive companies. Entrepreneurship. Collaboration networks. Ability to convert knowledge. Organizational performance.

Resumo

Objetivo: compreender quais são as relações antecedentes à maturidade tecnológica (MT) e ao desempenho organizacional (DO) em spin-offs acadêmicas e startups brasileiras. **Método:** pesquisa quantitativa, com aplicação de 62 questionários, sendo utilizados 17 como pré-teste. **Originalidade/Relevância:** este artigo desenvolve uma abordagem orientada para o empreendedorismo intensivo em conhecimento (EIC), no contexto de um país em desenvolvimento, utilizando dados obtidos junto a spin-offs acadêmicas e startups, com base em um modelo original, que relaciona os construtos estudados. **Resultados:** os achados empíricos permitiram realçar a importância da orientação empreendedora (OE) como antecedente, tanto da capacidade de conversão de conhecimento (CCC) quanto da capacidade de rede (CR). **Contribuições teóricas/metodológicas:** aspectos vinculados à OE, à CCC, à CR e à MT foram articulados em um modelo conceitual, com vistas a identificar, em última análise, os mecanismos determinantes do DO. **Contribuições sociais/para a gestão:** os resultados encontrados ressaltam o papel do ecossistema como metaestrutura crítica para o desenvolvimento empreendedor. Isso porque os componentes da OE, no nível da firma, estão intrinsecamente conectados à difusão de uma cultura de empreendedorismo nos agentes. Adicionalmente, tanto a CCC como a CR abarcam a dinâmica de interações e fluxos de conhecimento entre a firma e os agentes com capacidades complementares. Dessa forma, tais resultados apontam a necessidade de desenvolver uma orientação sistêmica, a fim de compreender novos EIC.

Palavras-chave: Empresas intensivas em conhecimento. Empreendedorismo. Redes de colaboração. Capacidade de conversão de conhecimento. Desempenho organizacional.

https://doi.org/10.14211/ibjesb.e2103
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INTRODUCTION

Knowledge intensive entrepreneurship (EIC) has been gaining prominence in the literature by representing new innovative firms, which generate systemic-level impacts on agents' capabilities and value creation (Audretsch et al., 2020; Fischer et al., 2021; Fischer, Queiroz, & Vonortas, 2018; Malerba & Mckelvey, 2020).

EIC is understood as a social-economic phenomenon, which fosters innovation and growth in production structures due to its potential for generating positive externalities (Duranton, 2007; Ferreira et al., 2017). In this context, academic spin-offs and startups are examples of the excellence of EIC expression.

Technology transfer processes from universities are associated with strategies for commercialization of research results (Bradley et al., 2013; Debackere & Veugelers, 2005). In this direction, there is a growing culture of firm creation from higher education institutions - the so-called academic spin-offs (Abreu & Grinevich, 2013; Hayter, 2016a; O'Shea et al., 2008; Rasmussen & Wright, 2015).

Therefore, the role of technology transfer, in the academic environment, carried out by academic spin-offs, stems from the work of researchers, students, and professionals, who begin to act in the field of entrepreneurship, presenting their research and knowledge to the production sector, thus enabling marketing the technologies developed at universities or within companies (Alves et al., 2019; Perez & Sánchez, 2003; Rothaermel et al., 2007).

There are several studies addressing the challenges for the establishment and success of these firms in the market, although strongly oriented towards developed countries (Hahn et al., 2019; Jain et al., 2009; O'Shea et al., 2008; Oehler et al., 2015; Rasmussen et al., 2014).

Among the aspects addressed are: (a) cultural factors, such as the personality and attributes of the individual founder; (b) university resources and capabilities, as well as the structure and policies directed to technology commercialization; and (c) determinants of the organizational performance (DO) of these firms.

Startups, in turn, emerge from entrepreneurs working in certain sectors who, upon identifying business opportunities, create companies with the potential to fill market gaps and achieve competitive advantages, based on their innovative capacity (Baum et al., 2000; Usman & Vanhaverbeke, 2017).

In Brazil, there are studies on innovation capabilities (Dullius & Schaeffer, 2016), characteristics of entrepreneurs (Maia, 2016) and the strategy of these firms (Rocha et al., 2019), in general, they approach their operating context (Bercovitz & Feldman, 2006; Civera et al., 2020), to identify which factors are related to the development of practices and capabilities (McGrath et al., 2019; Scuotto et al., 2020).

Nevertheless, although there were advances, gaps still remain for understanding the managerial mechanisms that affect performance within new EICs (Audretsch et al., 2020). They are due to the complexity of operating this type of firm, given the inherent uncertainty associated with innovative activities and, at the same time, the incipient stage of DO (Fischer et al., 2021).

Hence, a promising field regards analyzing the organizational factors related to the maturation of their technologies, and their approach to the market, using the relationship between different constructs. Some international articles present constructs related to entrepreneurial orientation (OE) (Clarysse & Moray, 2004; Diánez-González & Camelo-Ordaz, 2016; Mosey & Wright, 2017), as well as vectors associated with the relevance of networks in technology transfer (Huynh et al., 2017; Soetanto & Van Geenhuizen, 2015; Walter et al., 2006).

In the case of developing countries, there is little understanding about the specifics involved in the association dynamics between organizational factors and the relationships that influence the development of spin-offs and startups - especially considering the non-prevalence of this type of entrepreneurship in these countries (Lederman et al., 2014).

Therefore, this study sought to explore the relationship between entrepreneurial attitude and some managerial capabilities that measure how well management processes and practices are established in a firm (Silva et al., 2020), as well as its MT, that is, the possibility of technical and commercial application (Sousa-Ginel et al., 2017; Zahra et al., 2007).

Previous evidence highlights the existence of a different dynamic in the growth rate and organizational capabilities of new ventures in these countries, vis-à-vis the results found by new EICs located in developed countries (Eslava et al., 2019; Hsieh & Klenow, 2014). Thus, this article contributes to this literature, by studying the reality of Brazilian spin-offs and startups, through a micro orientation analysis, which sought to answer the following research question: what are the relationships that precede MT and DO in Brazilian academic spin-offs and startups?

Hence, this study addresses the challenge for the development and maturation of Brazilian spin-offs and startups, regarding how aspects of firm management relate to their technological evolution and economic performance. This research deepens the understanding on the dynamics of innovation within EICs, located in developing economic systems, in order to understand the main prior relationships of MT and DO in these types of firms.

Data used in this analytical exercise came from 62 new EICs, comprising university spin-offs and startups, located in six Brazilian states, in the Northeast and Southeast regions. The collection instrument was built from scales previously validated in the literature, addressing OE as an antecedent of CCC and CR, elements that, in turn, affect directly and indirectly MT and DO.

The results indicate the centrality of OE as a vector for determining CCC and CR, which ultimately affect DO. These findings bring new evidence on EIC management dynamics, in the context of a developing country, showing the essential character of managerial elements for the effective transformation of technological elements into superior business performance. These findings have implications not only for the management of new EICs, but also for policies that promote this entrepreneurial activity.

THEORETICAL BACKGROUND

The importance of entrepreneurial behavior for spin-offs and startups

EIC stands out in studies related to entrepreneurship and innovation (Fischer, Queiroz, & Vonortas, 2018; Malerba & McKelvey, 2020), especially because of the great potential for

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technological development in the environment where they operate (Bercovitz & Feldman, 2006; Civera et al., 2020). The factors that lead to the creation, practices, and internal processes that are responsible for the success of these companies have been objects of study in recent research (Audretsch & Belitski, 2021; Fischer et al., 2021; Malerba & McKelvey, 2020; Protogerou & Caloghirou, 2015), aiming to shed light on this dynamic.

These organizations operate in knowledge-intensive sectors, and their technological and innovation aspects are central elements of their value propositions (Malerba & McKelvey, 2020). Among them, academic spin-offs stand out - companies emerging from the university environment, with a strong scientific knowledge base (Mathisen & Rasmussen, 2019; O'Shea et al., 2008).

Such companies are usually created by researchers, who decide to commercialize technologies developed by them or in their laboratories (Hayter et al., 2018; Mathisen & Rasmussen, 2019), so that technology is transferred through the new company - the academic spin-off – that sells it to interested parties.

Thus, academic spin-offs are a relevant phenomenon for technology transfer and entrepreneurship (Scuotto et al., 2020), although relatively incipient in the Brazilian case (Fischer, Schaeffer et al., 2018).

Startups have also been the focus of several studies in the areas of technology and entrepreneurship, due to their performance in knowledge-intensive environments and potential to scale their business model (Symeonidou & Nicolaou, 2018).

Startups and academic spin-offs have equivalent typologies, and a company can often be classified as one or the other, due to their similarity in terms of strong scientific and technological knowledge base (Bathelt et al., 2010; Fryges & Wright, 2014; Silva et al., 2020).

However, the main difference between the two definitions is that a startup must have necessarily a recurring and scalable business model (Bortolini et al., 2018; Silva et al., 2020).). This opened up a broad research field on EIC, on the factors that are relevant for the creation and development of academic spin-offs and startups.

There are studies that address the relationship between organization members' prior entrepreneurial experience with DO (Clarysse & Moray, 2004; Mosey & Wright, 2007; Rasmussen, Mosey, & Wright, 2015; Wright et al., 2017); their ability to get funding (Huynh et al., 2017); as well as to form networks with other actors in related industries (Diánez-González & Camelo-Ordaz, 2019).

According to the literature, OE plays a key role in this dynamic of value creation in new ventures, because it comprises the processes associated with corporate strategy and firms' operational actions, oriented to the creation and capture of new market opportunities (Lumpkin & Dess, 1996). Thus, it works as a bridge between technological capabilities and their transformation into effective economic value, thus covering a wide range of approaches involved with the management of organizational knowledge (Fischer et al., 2021).

Studies addressing OE relate it to constructs of different management aspects (performance, capabilities), or organizational aspects, on how it affects and is affected by them (Diánez-González & Camelo-Ordaz, 2019; Wales et al., 2013).

Such elements emphasize the relational nature of new EICs (Alves et al., 2019; Stam & Van de Ven, 2021). Although internal aspects of these organizations are essential elements of their value propositions, the literature has progressively recognized the key role of entrepreneurship ecosystems in building competitive advantages for these firms (Ács et al., 2014; Li et al., 2016; Malerba & McKelvey, 2020; Radosevic & Yoruk, 2013). Therefore, relational (or network) capacities become critical components in the process of obtaining and internalizing knowledge, dispersed among external agents (Belso-Martinez & Diez-Vial, 2018; Leyden & Link, 2015).

Song et al. (2017) highlight the important role of networks for startups' acquisition of knowledge, and how OE moderates this acquisition and the actions for recognizing opportunities for these firms. Thus, in the creation and development of spin-offs and startups, the individual characteristics of participating members relate to, influence, and affect social aspects. These, in turn, are objects of study in the large research area of networks and the social context, relevant for generating technology-based companies (Diánez-González & Camelo-Ordaz, 2019; Huynh et al., 2017; McGrath et al., 2019).

From this discussion, we proposed the first hypothesis of this study:

H1: *OE has a positive impact on CR, in new EICs.*

The great challenge for members (researchers, founders, or managers) of academic spin-offs and scientific-technological-based startups is to turn knowledge in a given area into a tradable product. However, crossing the "death valley" in the innovation process is not trivial (Auerswald & Branscomb, 2003). Therefore, the higher the levels of OE, the greater the ability to take risks, innovate, and seek market opportunities (Diánez-González & Camelo-Ordaz, 2019).

Named in the literature as Knowledge Conversion Capability (Sousa-Ginel et al., 2017; Zahra et al., 2007), CCC is a challenge for this kind of companies, as many collapse in the "death valley". This happens due to the lack of managerial competencies, which are a prerequisite for translating technical knowledge into business competitiveness (Choi & Shepherd, 2004; Deeds et al., 2000; Vohora et al., 2004).

Thus, strategic management models, oriented to innovation, are essential components of value creation and economic performance in new EICs (Hahn et al., 2019; Hernández-Perlines et al., 2016; Katila et al., 2012; Soetanto & Jack, 2016; Symeonidou & Nicolaou, 2018).

We assumed, then, that OE - a central element of the firm's innovation culture - has a significant influence on CCC, given its catalytic role in the dynamics of transforming technical capabilities into value creation for the market..

To check the validity of this inference, a second hypothesis emerged:

H2: *OE has a positive impact on CCC, in new EICs..*

Knowledge networks as a path for technology transfer and technological evolution

Networks are environments favorable to cooperation, and many are created to promote innovation from participants' learning and collaborative work (Balestrin & Verschoore, 2010; Câmara et al.,

2018). In EIC, members are interested in technological development of products, technology transfer, intellectual property, and management learning – a kind of knowledge that researchers do not generally have (Hayter, 2016b; Huynh et al., 2017; Soetanto & Van Geenhuizen, 2015).

Based on this line of reasoning, Huynh et al. (2017), studied the capacities and networks of founding members of a spin-off, during its creation. The results showed increased entrepreneurial capabilities, due to their networks, which affected the growth stage of the spin-off. Therefore, spin-offs associate with networks to obtain advantages, mainly regarding technology transfer; we highlight the relevance of the offices responsible for this action, which are able to involve spin-offs and network participants, given their potential to leverage performance.

Gimenez-Fernandez et al. (2020) and Guerrero e Urbano (2017) noted that the establishment of external connections enables the expansion of a firm's technological competencies. Scuotto et al. (2017) further added such ties to the firm's innovative competence and absorptive capacities.

In this debate, a central factor for network association is the concept of CR, mentioned by Walter et al. (2006) as essential for knowledge-intensive firms. Several authors have stressed the importance of technology-based companies building strategic relationships for product development and their market insertion (Diánez-González & Camelo-Ordaz, 2019; Huynh et al., 2017; McGrath et al., 2019).

The ability to inserting oneself into certain social groups and building productive and lasting relationships with organizations and individuals present in the market is of central relevance, both for the entrepreneur, managers, and other employees of startups and spin-offs (Rasmussen, Mosey, & Wright, 2015).

As a company develops products and technology, increasing its CCC, it evolves in MT levels, assuming that it will increase its DO - one of the functions of increasing capacities of customer service and retention, translated into competitiveness gains (Vohora et al., 2004).

In addition, it is also important to check the influence of this relationship on the other constructs of the proposed model. Based on this assumption, and according to the research context, we proposed the third hypothesis:

H3: *CR has a positive impact on DO of new EICs.*

Technological evolution of spin-offs and startups

MT is a complex process of measurement and assessment, given that each industrial sector has its own peculiarities (strategies and techniques of management, of market, etc.). Among some of the scales developed to measure MT, the Technology Readiness Level (TRL) has played an essential role in gauging the level of product development and technology, in technology-based firms, especially in the European Union, where it is widely used to measure innovation projects (Héder, 2017).

In this discussion, an important construct that measures the organizational capacity of startups and spin-offs to convert knowledge into product or applied technology is CCC, as it develops technologies and advances MT levels.

Zahra et al. (2007), in their seminal article on the application of CCC in university and corporate spin-offs, address the difference of the construct and its dimensions when applied to these two types of spin-offs. They mention that CCC is divided into three levels of capability: (1) concept and vision - a phase in which the management team analyzes the existing knowledge, explores and defines the different potential for application, and determines who will need these applications; (2) configuration and design - development of operational and functional prototypes, which use this technology and configure products that can be manufactured and marketed; and (3) incorporation and integration - the company turns its knowledge into a product or an applied technological service.

Hence, based on the assumption that the ability of these firms' members can build, keep, and develop beneficial relationships with different actors (partners, competitors, suppliers, etc.) for technology transfer, justifying the development of MT and its ability to convert a given product/service/technology into something competitive is critical (Jolly, 1997; Sousa-Ginel et al., 2017; Vohora et al., 2004).

Sousa-Ginel et al. (2017) examined the relationship between the size and frequency of contacts in industrial networks of academic spin-offs with their CCC, understanding how the organization's tacit know-how influences this process.

Based on this discussion, we formulated the fourth hypothesis:

H4: *CR has a positive impact on CCC in new EICs.*

Additionally, following the concepts exposed by Sousa-Ginel et al. (2017) and Zahra et al. (2007), it is possible to infer that CCC has strategic relevance for new EICs. Thus, we assumed that CCC affects the MT level of its product or technology.

We then defined the fifth hypothesis:

H5: *CCC has a positive impact on the level of MT in new EICs..*

Furthermore, in academic spin-offs and startups, the product's MT can be measured by its level, which reflects the current state of the technology and its potential for application, considering that MT level can influence DO directly (Rompho, 2018). Hence, through DO, it is possible to measure how much the new EICs are, in fact, adding value and producing technology and innovation for the economy and society.

Therefore, we proposed the last hypothesis of the study:

H6: *The level of MT has a positive impact on DO, in new EICs.*

METHOD

Research sample

Collected by convenience and accessibility, considering the difficulty of a field survey in spin-offs and startups all over Brazil, the research sample covered the states of Ceará, Pernambuco, Piauí, and Bahia (Northeast region), and Minas Gerais and São Paulo (Southeast region).

To reach the proposed goal, we used connections and indications, starting from an active prospection of spin-offs and startups in the country, by the snowball method, in which the respondents indicated other potential participants.

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As a participation criterion, we used a filter to identify if the company was commercially active, that is, if it already had a functional prototype and initial levels of commercialization, and not in the stage of ideation or internal tests.

To access these firms, researchers immersed themselves in the field of study, participating in events for startups and of technology transfer for spin-offs. Between July and December 2019, they visited startup acceleration programs, coworking programs, incubators, and university technology parks.

The study also had the support of some local programs for developing startups, which enabled contact with a larger number of firms. In addition to these technical visits, we applied questionnaires through phone calls, using social media such as LinkedIn, WhatsApp, and Facebook. Hence, we got answers from managers of startups and spin-offs at different Brazilian locations.

We applied 62 questionnaires, with 17 used as pre-tests (included in the analysis of results, with a response rate of 17.03%). The majority that answered the questionnaire (66%) consisted of startups and spin-offs with less than two years in the market, that is, still in the initial phases of operation.

We excluded 16 companies from the analysis, because they did not have initial levels of commercialization, which means that they were still in the ideation and internal testing phases. Therefore, the final sample comprised 46 companies.

Result analysis and data collection instrument

To examine the results, we used the partial least squares - structural equations modeling (PLS-SEM), which estimates equations with multiple dependent variable (Lee et al., 2011). Using the Smart PLS 3.0 software, we continued with an exploratory analysis, in order to observe and understand, first, the relations between the formative constructs and the variables, not yet present in the literature, according to our model.

To design the data collection instrument, we operationalized the variables intrinsic to the dimensions of the constructs addressed in the theoretical framework. To do that, we defined the scale (a five-point Likert), the structure and order of the questions, as well as the format (Hair et al., 2000), according to scales used by several relevant authors in the field of EIC (Sousa-Ginel et al., 2017; Walter et. al., 2006).

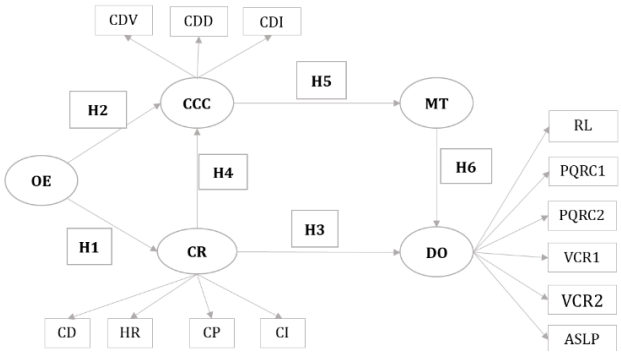
Hence, the variables that made up the research instrument were defined based on the confluence of theoretical aspects raised in the literature, associated with the topics of academic spin-offs, startups, and technology transfer, including constructs widely used by studies in these areas (Tables 1 to 5).

Theoretical-conceptual research model

Based on the hypotheses, variables, and constructs previously mentioned, we present the Theoretical-Conceptual Model of the Research, relating the constructs and showing the relationships between the hypotheses (Figure 1).

Figure 1

Theoretical-Conceptual Research Model



Note: Elaborated by the authors (2021).

RESULT ANALYSIS

Validity and reliability tests and model significance

To begin assessing the model, first we examined its validity, by analyzing the average variance extracted (AVE), and its reliability, through Cronbach's Alpha and composite reliability.

We checked that the indexes were adequate, since they had AVE > 0.5 (Table 6), although two constructs showed a value below 0.5 (MT and DO). Even so, we chose to keep them in the analysis, due to the tolerance allowed when the research is exploratory and AVE has a value close to 0.5 (Bido & Silva, 2019; Little et al., 1999).

Regarding the model's reliability values, all constructs had values close to 0.7 for Cronbach's Alpha, and above 0.7 for composite reliability; therefore, the constructs were reliable for measuring the proposed model and its subsequent hypothesis test (Bido & Silva, 2019).

Table 6

Model Validity and Reliability

Description	Cronbach's Alpha	Composite Reliability	Average Variance Extracted (AVE)
CCC	0.871	0.904	0.612
CR	0.835	0.868	0.333
DO	0.683	0.792	0.420
MT	1.000	1.000	1.000
OE	0.676	0.795	0.504

Note: Elaborated by the authors, based on survey data (2021).

After validity and reliability analyses, we evaluated the statistical significance of the constructs used in the study, by checking the adjusted R^2. The constructs had statistical significance, except for MT, whose p-value was > 0.05 (Table 7).

Table 7

Model Significance (R^2)

Description	Original Sample	Sample Average	Std. Dev.	T Statistics	P Value
CCC	0.393	0.418	0.124	3.169	0.001
CR	0.742	0.762	0.065	11.325	0.000
DO	0.311	0.408	0.121	2.561	0.010
MT	0.026	0.041	0.045	0.575	0.566

Note: Elaborated by the authors, based on survey data (2021).

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Table 1

Network Capacity Variables (CR)

Code	Variables	Authors
Coordination (CD)		
CD1	"We got information on goals, potential, and strategies of our partners".	
CD2	"We previously defined which partners to talk to about building relationships".	
CD3	"We regularly discussed with our partners how to support each other to be successful".	
Relational Skills (HR)		
HR1	"We are able to build good personal relationships with business partners".	
HR2	"We can put ourselves in our partners' position".	
HR3	"We can deal with our partners flexibly".	
HR4	"Most of the time, we solve problems with our partners usefully".	Walter et al. (2006)
Partner Knowledge (CP)		
CP1	"We know our partners' market".	
CP2	"We know our partners' products/procedures/services".	
CP3	"We know the potential and strategies of our competitors".	
Internal Communication (CI)		
CI1	"In our organization, we have regular meetings for each project".	
CI2	"In our organization, employees develop informal contacts with each other".	
CI3	"In our organization, information exchange takes place often and spontaneously between projects and thematic areas".	
CI4	"In our organization, managers and employees give intensive feedback to each other".	

Note: Elaborated by the authors (2021).

Table 2

Variables for Knowledge Conversion Capacity (CCC)

Code	Variables	Authors
Vision Capacity (CDV)		
CDV1	Identify market applications for the firm's knowledge/technology.	
CDV2	Identify different groups of customers that may be interested in your products or services.	
Design Capacity (CDD)		
CDD1	Design alternative prototypes for your firm's products or services.	Sousa-Ginel et al. (2017)
CDD2	Analyze several combinations of attributes for your products or services.	Zahra et al. (2007)
Integration Capacity (CDI)		
CDI1	Assimilate your suppliers and partners' knowledge in your new products or services.	
CDI2	Apply your company's different skills in developing new products or services.	

Note: Elaborated by the authors (2021).

Table 3

Entrepreneurial Orientation Variables (OE)

Code	Variables	Authors
Entrepreneurial Orientation		
OE1	"In this organization, entrepreneurial behavior is a central principle".	Diánez-González e
OE2	"In this organization, we emphasize innovation above all".	Camelo-Ordaz (2019)
OE3	"In this organization, people are willing to take risks".	Walter et al. (2006)
OE4	"In this organization, people are always anxious to be the first to market".	

Note: Elaborated by the authors (2021).

Table 4

Variables for Technological Maturity Level

Code	Variables	Authors
Technological Maturity Level		
MT1	What stage is your core technology at? Classify into: (1) idea phase; (2) testing phase in a controlled environment – in the firm's internal processes; (3) testing phase in a real environment – directly with customers; (4) initial phases of marketing; (5) commercial-scale production capacity and financial equilibrium; and (6) intensive production capacity and commercial scheduling.	Jolly (1997) Héder (2017)

Note: Elaborated by the authors (2021).

Table 5

Organizational Performance Variables (DO)

Code	Variables	Authors
Profit Realization (RL)		
RL1	Profit increase	
Perceived Quality of Customer Relationship (PQRC)		
PQRC1	Customer satisfaction	
PQRC2	Customer retention	Walter et al. (2006)
Achieved Competitive Advantages (VCR)		
VCR1	Advantages in product customization over our competitors	
VCR2	Cost advantages over our competitors	
Ensuring Long Term Survival (ASLP)		
ASLP1	Long term survival of our organization	

Note: Elaborated by the authors (2021).

Analysis of the theoretical-empirical model

With the exception of the constructs related to MT, whose values were insufficient to validate their statistical significance, the others presented it (Table 8), with p-values below 0.05, and t-test values higher than 1.96.

Table 8

Path Coefficients of the Adjusted Model

Description	Original Sample	Average Sample	Std. Dev	T Statistics	P Value
CCC -> CR1	0.654	0.650	0.122	5.360	0.000
CCC -> MT	0.160	0.166	0.114	1.401	0.161
CR -> DO	0.443	0.492	0.171	2.591	0.010
MT -> DO	0.267	0.253	0.175	1.529	0.126
OE -> CCC	0.627	0.638	0.102	6.149	0.000
OE -> CR	0.285	0.291	0.134	2.131	0.033

Note: Elaborated by the authors, based on survey data (2021).

The results of the structural model (Table 9) indicate how well the variables represent the corresponding constructs. In this case, some had very low indexes, such as variables CD2 (0.213), CP1 (0.328), CP2 (0.258), and VCR2 (0.170). Thus, we decided to remove them from the model, thus reaching the final model presented in the next section.

Table 9

Results of the Structural Model

Variable	CCC	CR	OE	MT	DO
CDD1	0.842				
CDD2	0.874				
CDI1	0.743				
CDI2	0.805				
CDV1	0.755				
CDV2	0.656				
CD1		0.487			
CD2		0.435			
CD3		0.742			
CI1		0.685			
CI2		0.556			
CI3		0.635			
CI4		0.649			
CP1		0.318			
CP2		0.271			
CP3		0.502			
HR1		0.672			
HR2		0.655			
HR3		0.525			
HR4		0.710			
MT				1.000	
OE1			0.436		
OE2			0.749		
OE3			0.789		
OE4			0.801		
ASLP					0.644
PQRC1					0.640
PQRC2					0.737
RL					0.818
VCR1					0.683
VCR2					0.124

Note: Elaborated by the authors, based on survey data (2021).

Final theoretical-empirical model

Validity and reliability tests and model significance

After removing the six variables mentioned before (OE1, CD1, CD2, CP1, CP2, and VCR2), we reached a final model (Table 10). Therefore, we noticed an improvement in AVE, CR, and DO, with values close or above 0.5; the other constructs did not show significant changes.

With regard to Cronbach's Alpha, the DO construct showed a significant increase, with an index of 0.771 and composite reliability growing from 0.792 to 0.877. However, OE had a slight increase.

Table 10

Validity and Reliability of the Final Model

Description	Cronbach's Alpha	Composite Reliability	Average Variance Extracted (AVE)
CCC	0.871	0.904	0.613
CR	0.843	0.877	0.419
DO	0.771	0.835	0.507
MT	1.000	1.000	1.000
OE	0.691	0.828	0.507

Note: Elaborated by the authors, based on survey data (2021).

As for constructs' statistical significance, there were no changes for MT. The others showed statistical significance, with p value < 0.05 and t test > 1.96 (Table 11).

Table 11

Model Significance (R^2)

Description	Original Sample	Sample Average	Std. Dev.	T Statistics	P Value
CCC	0.421	0.436	0.126	3.346	0.001
CR	0.749	0.762	0.066	11.277	0.000
DO	0.290	0.370	0.113	2.557	0.011
MT	0.026	0.042	0.046	0.567	0.571

Note: Elaborated by the authors, based on survey data (2021).

Analysis and discussion of the final theoretical-empirical model

By removing the four variables mentioned before, we reached a final model (Table 12), with coefficient paths similar to those of the previous model, and no statistical significance in the relationship between CCC and MT. This result was achieved from a bootstrapping of 5000, and a significance level of 0.05 - recommended in studies of the Social Sciences area.

Table 12

Path Coefficients of the Final Model

Description	Original Sample	Sample Average	Std. Dev.	T Statistics	P Value
CCC -> CR	0.654	0.650	0.121	5.411	0.000
CCC -> MT	0.160	0.168	0.116	1.381	0.167
CR -> DO	0.443	0.487	0.179	2.473	0.013
MT -> DO	0.267	0.256	0.173	1.544	0.123
OE -> CCC	0.627	0.638	0.102	6.123	0.000
OE -> CR	0.285	0.290	0.132	2.153	0.031

Note: Elaborated by the authors, based on survey data (2021).

Thus, it is possible to reach a theoretical-empirical model that represents the proposed hypotheses (Figure 2). The beta coefficients of the relations between the constructs show how much each one affects the other. Hence, it is possible to make the necessary interpretations in order to formulate the proposed model (Table 13).

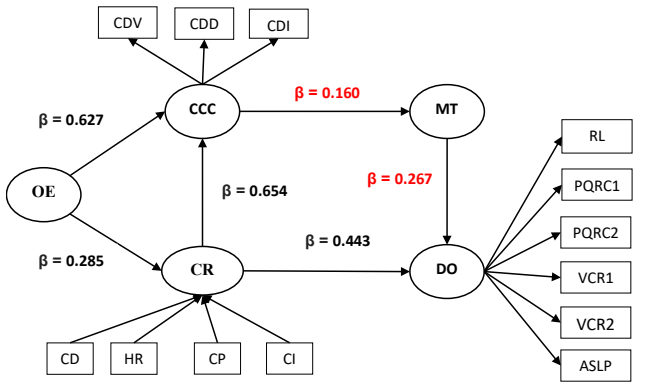
We found that OE affects both CCC and CR, showing the importance of entrepreneurial behavior for the development of spin-offs and startups, at both the individual and organizational levels (Choi & Shepherd, 2004; Deeds et al., 2000; Vohora et al., 2004).

This result supports previous research findings (Huynh et al., 2017; Soetanto & Van Geenhuizen, 2015), emphasizing issues linked to the managerial approaches of new EICs. This view goes beyond the purely technological aspects of these ventures, given

the centrality of management capacities as influential elements of OE (Zacca & Dayan, 2018), as well as their respective impacts on the development and competitiveness of new firms (Cowling, 2016; Katila et al., 2012; Siepel et al., 2017).

Figure 2

Final Theoretical-Empirical Model



Note: Elaborated by the authors, based on survey data (2021).

Table 13

Hypotheses of the Theoretical-Empirical Model

Hypotheses	Values		Situation
	β	p-value	
H1 OE has a positive impact on CR	0.285	0,031	Accepted
H2 OE has a positive impact on CCC	0.627	0,000	Accepted
H3 CR has a positive impact on DO	0.443	0,013	Accepted
H4 CR has a positive impact on CCC	0.654	0,000	Accepted
H5 CCC has a positive impact on MT level	0.160	0,167	Rejected
H6 MT level has a positive impact on DO	0.267	0,123	Rejected

Note: Elaborated by the authors, based on survey data (2021).

CR in turn, showed impact on DO, proving that the ability to join organizational networks has direct effects on these companies' performance. This occurs through access to external knowledge, generation of value co-creation processes, and increase of capabilities to identify marketing opportunities (Leyden & Link, 2015).

Ultimately, such connection dynamics promotes gains in innovation, through knowledge flows that expand the scale and scope of knowledge available to new EICs (Guerrero & Urbano, 2017; Siegel & Wessner, 2012). This dynamic is aligned with the perspective that an EIC is essentially associated with the ecosystem where it is located, comprising aspects of market, technology, and institutional environment (Fini et al., 2011; Radosevic & Yoruk, 2013; Zucker et al., 2002).

We observed that CR influences CCC, which may indicate that the insertion in technological and business development networks depends on the organization's ability to evolve technologically. In other words, the more the company participates in networks that enhance technological and management advance, the greater the possibility that the startup will develop capabilities that will influence the creation and improvement of products and technologies; thus, this is coherent with studies that identify the formation of networks as inducers of the evolution of capabilities in small businesses (Scuotto et al., 2017). This finding indicates a pattern in innovation processes in the Brazilian context, compared to observations in developed countries.

We found no effect of CCC on MT, hypothesis H5, nor any influence of MT on DO, hypothesis H6. This, in a way, isolated MT in the model, causing CCC to affect the performance of the studied companies only through CR. Thus, performance is generated by CR, but DO is not influenced by MT, and this does not stem from CCC. This deviation from what was expected was probably due to the fact that most firms have higher levels of MT, and maybe there was not enough variability in the sample to capture the relationship of MT with CCC and DO.

FINAL REMARKS

EICs have been gaining prominence as a central element in the dynamics of economic development (Qian & Haynes, 2014). Nevertheless, the closeness of these activities with the generation of innovations implies increasing managerial complexity (Hyytinen et al., 2015).

Therefore, advancing knowledge on the determinants of business capabilities and organizational performance of these new firms has become a relevant field of research for generating economic contributions at micro, meso, and macro levels (Audretsch et al., 2020).

However, the debate on EIC has traditionally occurred from a linear perspective, emphasizing resource allocation to business activities over more comprehensive approaches to the effective management of these firms (Brown & Mason, 2014). Hence, technological aspects should be understood as part of broader structures.

We achieved the article's goal, since it was possible to: (a) determine the relationships that precede technological maturity and organizational performance in academic spin-offs and startups; (b) determine the nature of the relationships between the constructs addressed in the research; (c) link aspects of OE, CCC, CR and MT, articulating them in a conceptual model to identify the determining mechanisms of DO; and (d) contribute to the subject's debate, through an approach oriented to a developing country's issues (Brazil), with data from academic spin-offs and startups..

The empirical results show the relevance of OE as an antecedent of both CCC and CR. We could not observe effects of CCC on the degree of MT, and of MT on firms' DO, proving the complexity of the mechanisms that underlie the processes of innovative capabilities' evolution in new EICs (Vohora et al., 2004) and their influence on firm performance (Sousa-Ginel et al., 2017; Walter et al., 2006). CR (influenced by CCC), in turn, is an essential vector for determining organizational outcomes.

In a broad sense, these findings highlight the role of the ecosystem as a critical meta-structure for entrepreneurial development, because the components of OE at the firm level are intrinsically connected to the diffusion of a culture of entrepreneurship among the agents (Qian, 2018). In addition, both CCC and CR embrace the dynamics of interactions and knowledge flows between the firm and agents with complementary capabilities (Stam & Van de Ven, 2021).

Hence, the results of this study show the need to develop a systemic orientation for understanding new EICs, both from the firm's standpoint - seeking to manage their innovation activities based on a strategic approach oriented to risk taking and articulation with other components of the ecosystem; and from

https://doi.org/10.14211/ibjesb.e2103
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the standpoint of formulating development policies, which should not only focus on technological development, but also the managerial capabilities and the OE in the target firms.

The paper lists the prior relationships that affect MT and the performance of academic spin-offs and startups, and sheds light on the importance of understanding the impacts on the relationship between these constructs, by presenting a theoretical-conceptual model.

Furthermore, it highlights the relevance of CCC - the company's ability to generate value from acquired knowledge, and how it is strongly affected by OE and CR. This shows the importance of entrepreneurial attitude and the capacity to connect with different actors for converting knowledge into a marketable product, adding value to stakeholders.

This paper may assist in the formulation of public policies in the area, and the management of knowledge-intensive companies, given the relevance of these constructs for the development of these firms. In addition, it extends the discussion on the relationships between the constructs addressed. Therefore, it becomes evident that technological capabilities are necessary, but not sufficient, conditions for the success of new EICs. The incorporation of systems for strategic knowledge management seems to be a welcome action for firms to achieve competitiveness.

These contributions to the literature bring new elements to enrich the debate on EIC in developing countries. Nevertheless, there are some limitations to the presented approach that deserve attention. First, the small size of the sample does not allow inferring that the results represent the Brazilian population of new EICs. Also, due to its cross-sectional nature, the research does not enable assessing evolutionary characteristics of the relationships observed in the sample firms. Hence, additional use of this approach, both transversal and longitudinal, may bring relevant inputs for deepening these discussions. Also, in-depth case studies are necessary to provide a more complete vision on the relations between the proposed constructs.

Acknowledgements

We would like to thank IDESCO - Instituto Desenvolvimento, Estratégia e Knowledge, for the support with the research and translation of the article.

Funding

This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES) - Finance Code 001.

Conflict of interest statemen

The authors declare that there is no conflict of interest.

Authors' statement of individual contributions

Roles	Contributions			
	Lima BB	Câmara SF	Fischer BB	Magalhães RC
Conceptualization	■	■	■	■
Methodology	■	■	■	
Software	■			
Validation	■		■	■
Formal analysis	■		■	■
Investigation	■			
Resources	■		■	
Data Curation	■			
Writing - Original Draf	■		■	■
Writing - Review & Editing	■	■	■	■
Visualization	■			■
Supervision		■		
Project administration	■	■		
Funding acquisition	■			

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https://doi.org/10.14211/ibjesb.e2103
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