Research Article

The absorptive capacity and the diffusion of innovation in NTBFs and startups: A study in the Brazilian Federal District

Bruno Alencar Pereira[a]* iD e Josivania Silva Farias[a] iD

[a] *Universidade de Brasília, Brasília, DF, Brasil*

Open access

Check for updates

*Autor de contato:

Bruno Alencar Pereira
bruno.pereira@flinders.edu.au
Currently at:
Flinders University, Adelaide, SA, Australia

Resumo

Objetivo: Verificar a contribuição da Capacidade Absortiva (ACAP) para a difusão da inovação em Novas Empresas de Base Tecnológica (NEBTs) e startups estabelecidas no Distrito Federal brasileiro. **Método**: Estudo de entrevistas em profundidade com 20 empreendimentos inovadores, 12 (doze) startups e 8 (oito) NEBTs. Os resultados discutem dois itens de análise: Análise do perfil dos empreendimentos e a Análise da Classificação Hierárquica Descendente (CHD) e de conteúdo, em uma perspectiva comparativa acerca de 14 categorias temáticas. **Resultados**: Observou-se que fatores de desenvolvimento do Potencial da Capacidade Absortiva (PACAP) atuam como antecedentes da difusão da inovação. Já os fatores relacionados à Capacidade Absortiva Realizada (RACAP) estão envolvidos diretamente com a difusão da inovação, com destaque para a capacidade de gerar resultados de inovação por meio de canais de introdução mercadológica, adoção de novas tecnologias e investimentos financeiros. **Contribuições teóricas/metodológicas**: O estudo contribui para o campo teórico, ainda carente de produção especialmente regional, sobre a relação entre os construtos investigados no contexto de empreendimentos inovadores. Mecanismos de apoio, podem obter insights para aprimorarem o suporte oferecido que facilitem o acesso ao conhecimento a ser absorvido para sua conversão em inovações. **Relevância/originalidade:** A pesquisa amplia a compreensão da relação entre a ACAP e a difusão da inovação, envolvendo a absorção de conhecimento e a dinâmica destes construtos por meio de fatores críticos em contextos específicos ainda pouco investigados, como nas NEBTs e startups envolvendo ecossistemas regionais de inovação. **Contribuições gerenciais/sociais:** A investigação empírica e fatores abordados fornecem possíveis implicações gerenciais para práticas dos próprios empreendimentos ao desenvolverem inovações, bem como para o planejamento, desenvolvimento ou para o fortalecimento de ambientes e políticas de apoio.

Palavras-chave: Capacidade absortiva. Inovação. Difusão tecnológica. Startups. Novas empresas de base tecnológica

Absorptive capacity and the diffusion of innovation in NTBFs and startups: A study in the Brazilian Federal District

Abstract

Purpose: To verify the contribution of the Absorptive Capacity (ACAP) to the diffusion of innovation in New Technology-Based Firms (NTBFs) and startups in the Brazilian Federal District. **Method:** In-depth interviews study with 20 innovative firms, 12 (twelve) startups and 8 (eight) NTBFs. The results are discussed in two items of analysis: Analysis of the profile of the firms and the Analysis of the Descending Hierarchical Classification (DHC) and of the content, in a comparative perspective around 14 thematic categories. **Results:** The development factors associated with the Potential of Absorptive Capacity (PACAP) were observed as the antecedents of the diffusion of innovation. On the other hand, factors related to the Realized Absorptive Capacity (RACAP) are involved directly in the diffusion of innovation, with emphasis on the ability to generate innovation results through channels of market introduction, adoption of new technologies and financial investments. **Theoretical/methodological contributions:** The study contributes to the theoretical field, still lacking in production, especially regionally, on the relationship between the constructs investigated in the context of innovative firms. Supporting programs, can gain insights to improve the advanced support that facilitates access to knowledge to be adopted and conversion into innovation. **Relevance/originality:** The research extends the understanding of the relationship between ACAP and the diffusion of innovation, involving the absorption of knowledge and the dynamics of these constructs through the integration of critical factors in specific contexts still little investigated, such as in NTBFs and startups involving regional innovation ecosystems. **Management/ Social Contributions:** The empirical investigation and factors addressed provide managerial implications for the practices of these firms when developing innovations, as well as for planning, developing or strengthening innovation programs and policies.

Keywords: Absorptive capacity. Innovation. Technological diffusion. Startups. New technology-based firms.

INTRODUCTION

Based on the seminal work of Cohen and Levinthal (1990), the Absorptive Capacity (ACAP) corresponds to the previous collective skills and knowledge of an enterprise that allow the recognition of the value of a new information, idea, or insight for assimilation and market application as a critical factor for their ability to innovate

The relationship between ACAP and the diffusion of innovation is based on the understanding that diffusion is a process by which the innovation developed from the knowledge absorbed is transmitted to the members of the social system through communication channels, involving a decision-making process and innovative (Rogers, 1983). However, few studies investigate the relationship between ACAP and the diffusion of innovation, mainly related factors or specific contexts involving new ventures such as New Technology-Based Firms (NTBFs) or startups (Flechas Chaparro et al., 2021). Advances in ACAP, new types of enterprises and the involvement of regional innovation ecosystems become relevant contexts for studies that align ACAP with innovation diffusion processes, and for managerial practices involving capacity-building initiatives.

NTBFs and startups are innovative businesses immersed in risk environments and important mechanisms for the diffusion of innovations (Cuvero et al., 2019). By obtaining the knowledge to innovate, NTBFs and startups have characteristics that facilitate the development of ACAP, such as entrepreneurial orientation, open-mindedness to innovation, strategic flexibility, and lean structure to test, adapt and validate innovations through agile means. By enabling value creation, innovation, and sustained competitive advantage, ACAP becomes a relevant construct and a promising application in these types of businesses. According to Zheng et al. (2010), there is evidence that innovative capacity is correlated with the growth potential and performance of NTBFs and startups. However, such evidence still does not systematically supply knowledge about the relationship between knowledge absorption and the diffusion of innovation.

In this context, this research investigated how ACAP contributed to the diffusion of innovation in NTBFs and startups established in the Federal District. The ecosystem of the Brazilian Federal District was chosen as the specific locus of the research, being the largest startup community in the Midwest region, with 209 active startups (ABStartups, 2019).

For the theoretical field, originally, the research expands the understanding of the relationship between ACAP and the diffusion of innovation, involving the absorption of knowledge and the dynamics of these constructs through the integration of critical factors in specific contexts, still little investigated, as in NTBFs and startups. Additionally, it provides results for regional production on innovation and the relationship between the constructs. The research has managerial implications for the practices of these enterprises, as well as for the planning, development or strengthening of innovation hubs, identifying critical factors, and providing insights to improve the support offered to these enterprises. Still, it highlights the potential of policies to support innovation in regional contexts.

In the following sections of the study, the concepts and evolution of ACAP are presented, exploring relevant development factors and their consequences on the diffusion of innovation in NTBFs and startups. Followed by the adopted methods, analysis of the results, and conclusions.

THEORETICAL FOUNDATION

Cohen and Levinthal (1990) coined the term Absorptive Capacity or ACAP (Absorptive Capacity) relating it to the ability of a company to recognize the value of new external information, assimilate it and apply for commercial purposes, as three fundamental aspects for innovation and its diffusion. In this process, the ACAP occurrence and associated factors strongly influence the processes, decisions and diffusion events for creation and adoption of an innovation (Rogers, 1983; Cohen & Levinthal, 1990).

Since 1990, understanding of innovation processes has been enhanced by research on the capacity to absorb knowledge (Mason et al., 2020). However, although the discussion about ACAP has been widespread, factors that explain its occurrence have rarely been investigated. Zahra and George (2002) advanced in the evolution of the ACAP concept, introducing factors that improved the systematic understanding of the construct, dividing it into two components: the Potential Absorptive Capacity (PACAP) involving acquisition and assimilation, and the Realized Absorptive Capacity (RACAP) with the dimensions transformation and exploration of knowledge. With its evolution, ACAP became, therefore, a crucial construct for the creation of innovations and a fundamental element for organizational strategies.

From the 2000s, advances on the subject are observed in four macro perspectives, such as discussions on 'ACAP and Networks' involving collaborations with external actors, knowledge transfer, and open innovation (Rothaermel & Thursby, 2005; Benson & Ziedonis, 2009; Fukugawa, 2013; Flor et al., 2017; von Briel et al., 2019; Kato, 2020); 'ACAP, Antecedents and Potential for Realization' relating PACAP and impact on innovation performance, degree of innovation, and measurement scales (Deeds, 2001; Nooteboom et al., 2007; Camisón & Forés, 2010; Teigland et al., 2014; Hughes et al., 2017; Ho et al., 2020; Chung et al., 2021); 'ACAP and Internal or External Factors/Resources' involving exploitation of resources, factors for innovation production, and dynamic capabilities (Jantunen, 2005; Serrano-Bedia et al., 2012; Wang et al., 2016; Yang et al., 2019); and 'ACAP and Innovation Strategies' relating strategic positioning, creation of technological knowledge, organizational culture and knowledge economy (Veugelers & Cassiman, 1999; Mueller, 2007; Anatoliivna, 2013; Luo et al., 2017; Dabic et al., 2020).

ACAP advances and discussion have been repeatedly investigated in business and innovation; however, there is still a methodological gap specifying its theoretical domain around NTBFs and startups (Jantunen, 2005; Flechas Chaparro et al., 2021). NTBFs are new and relatively small companies that operate with intensive use of technology, seeking to commercialize their innovations and accelerate the diffusion of technologies to users (Lindelöf & Löfsten, 2003; Motohashi, 2005). Startups are temporary and small organizations designed to seek a repeatable and scalable business model, creating and introducing innovations in the market (Blank & Dorf, 2012; Marcon & Ribeiro, 2021).

Relating ACAP to the diffusion of innovation in NTBFs and startups, the literature highlights critical factors such as antecedents of PACAP that contribute to the conversion of knowledge absorbed in technological processes as antecedents of the diffusion of innovation. These factors are: organizational capacity (Malik & Wei, 2011; Aribi & Dupouët, 2015), openness to innovation (Malik & Wei, 2011; Garengo, 2019), social capital, networks, partnerships, and cognitive capacity (Cuvero et al., 2019), means of acquiring knowledge (Nooteboom et al., 2007; Zheng et al., 2010), ability to acquire, develop and manage knowledge (Aribi & Dupouët, 2015; Garengo, 2019), learning ability (Malik & Wei, 2011; Sheng & Chien, 2016), and the ability to use organizational resources (Garengo, 2019).

Likewise, absorptive capacity factors related to RACAP are evidenced in the literature with a strong relationship to innovation diffusion processes as potentiating elements to create innovation and its respective market introduction. These factors include human capital for innovation (Mueller, 2007), RD&I capacity (Burcharth et al., 2015; Ubeda et al., 2019), technological capacity (Wang et al., 2016; Hötte, 2020), protection of knowledge,

technology, innovation and appropriability (Li et al., 2015), ability to generate innovation results through marketing introduction channels (Barnett et al., 2011), ability to create innovation results through new technologies and financial investments (Wang et al., 2016), and ability to generate innovation results related to market introduction barriers (Barnett et al., 2011; Cuvero et al., 2019).

To better understand the occurrence of ACAP in NTBFs and startups, the factors linked to PACAP and RACAP are discussed in the following subsections and used as theoretical bases and support for the interview script and analysis of the research results.

Relevant factors for the acquisition and assimilation of knowledge absorbed from PACAP

As a multidimensional construct, ACAP in NTBFs and startups requires the research of factors to obtain different types of knowledge absorbed, as well as for the diffusion of innovation (Larrañeta et al., 2017; Flechas Chaparro et al., 2021). Next, relevant factors for the occurrence of ACAP and the diffusion of innovation are discussed.

Organizational capacity – Refers to the organizational structure and technological trajectory facilitating the identification and assimilation of knowledge to innovate. Thus, the identification of technology opportunities and knowledge transfer is promoted (Malik & Wei, 2011; Aribi & Dupouët, 2015).

Innovation Openness – Corresponds to the organizational mindset for obtaining external knowledge, which leads customers, other organizations, or companies to extend internal knowledge and resources to create innovations aimed at market success (Malik & Wei, 2011; Garengo, 2019).

Social capital, networks, partnerships, and cognitive capacity – These are external collaborations and knowledge acquisition processes, whose most common forms are: collaboration with other entrepreneurs, innovation ecosystems, universities, or with customers and suppliers (Cuvero et al., 2019).

Means of acquiring knowledge – Involves means of achieving heterogeneity of resources, involving the cognitive distance between partners or other sources of knowledge, adaptation to the environment, internationalization, previous experience, and capabilities, or organizational structure (Nooteboom et al., 2007; Zheng et al., 2010).

Capacity for knowledge acquisition, development, and management – It is associated with the absorption of knowledge to produce innovation demanded by organizational management capacity, involving a reflective and critical mindset, and capacity for exploring and managing innovation (Aribi & Dupouët, 2015; Garengo, 2019).

Capacity for learning – It is the preparation of the company and the learning process for absorbing external knowledge, helping enterprises to become more innovative and competitive (Malik & Wei, 2011; Sheng & Chien, 2016).

Capacity to use organizational resources – These are the existing resources and the resource management capacity to innovate, encompassing investment in physical resources, supply chain, etc. (Wang et al., 2016; Garengo, 2019).

Relevant factors for the transformation and exploitation of knowledge for the diffusion of innovation related to RACAP

Human capital for innovation – is the experience to innovate involving the use of knowledge, experience and internal competence or coming from external collaborators (Wang et al., 2016; Larrañeta et al., 2017; Mueller, 2007).

RD&I Capacity – These are internal technological capacities and external collaborations. Partnerships for RD&I are key sources of information through formal and social links, research projects, patents, prototypes, and consultancy, including partnerships with innovation environments (Burcharth et al., 2015; Ubeda et al., 2019).

Technological capacity – Refers to pre-existing knowledge and the search for complementary knowledge and skills to innovate (Wang et al., 2016). External partnerships help enterprises to become more innovative and competitive, in which absorbed technological capabilities influence productivity in technology development (Hötte, 2020).

Protection of knowledge, technology, innovation, and appropriability - These are strategies of appropriability and protection of technology to obtain a competitive advantage, approaching traditional means of protecting intellectual property. Another measure may be early publication or market pioneering, bringing positive benefits to reputation (Li et al., 2015).

Capacity to generate innovation results through market introduction channels – These are innovation results and their introduction into the market through different channels, encompassing two diffusion factors: the innovation must be appropriate to the context in which it is disseminated and communication broadcast vectors must be in place to transmit information (Barnett et al., 2011).

Capacity to generate innovation results through new technologies and financial investments – These are the results of innovation through easier access to new technologies and investments for marketing dissemination. Financial investments received or invested make it possible to increase dissemination (Wang et al., 2016).

Capacity to generate innovation results related to market introduction barriers - External factors can prevent or promote the creation and diffusion of innovation, determining the speed and pattern of dissemination. Some barriers include political, economic, infrastructure, or internal factors such as lack of human capital, resources, and networking (Barnett et al., 2011; Cuvero et al., 2019).

METHODOLOGY

This study is a descriptive and qualitative study using interviews. Data collection was carried out in 20 innovative ventures, 12 (twelve) startups, and 8 (eight) NTBFs. The number of interviews is based on Fontanella et al. (2011) as a sampling process by theoretical saturation, in which data collection was interrupted when it was found that new elements were no longer inferred from the field of observation.

For the selection of interviews, there was an initial registration of 155 enterprises, prospected on the websites of business incubators and accelerators in the Federal District, Censos Abstartups, Portal StartaSe, as well as on lists of innovative enterprises contemplated in public notices promoted by the Fundação de Apoio à Pesquisa do Distrito Federal (FAPDF). Projects in a very early stage of development or inactive were removed, remaining 111 entries, with 20 projects selected and invited for interviews.

The interview script (Appendix 1) was prepared in two parts. The first is with 18 items related to the profile of the enterprise, such as area of activity, innovation, company size, support and investment received, etc. And the second with 15 items related to the factors discussed in the literature, for example: During the technological trajectory of the enterprise, how did you organize yourself to obtain knowledge to innovate? Assertive related to the factor "Organizational capacity" linked to PACAP.

The participants, founders and managers of the ventures, were invited to participate in the survey by sending an email or LinkedIn. The interviews took place between August and November of 2020, with an average duration of 60 minutes, using the Zoom platform.

The interviews were transcribed, and, as a data processing technique, content analysis was applied (Bardin, 1977). The a priori thematic categorization and the textual analysis were carried out with the support of the IRAMUTEQ software for the treatment, organization, analysis, and interpretation of the data (Camargo & Justo, 2013).

The results analysis were carried out in three steps. First, with the investigation and description of the profile of the enterprises investigated. Second, a textual analysis was performed using Descending Hierarchical Classification (DHC). Third, through content analysis based on the interviewees' reports. In the content analysis on the absorptive capacity for innovation, the comparative perspective between NTBFs and startups was adopted in search of similarities and distinctions about 14 thematic categories of analysis, presented in the theoretical section.

Regarding any qualitative work, the researchers remained alert to the possibility of the emergence of new thematic categories (a posteriori), as advocated by Bardin (1977). However, it was verified that the categories already raised a priori, in the literature used in the study, were sufficient for the analysis, discussion and interpretation of the results obtained in the research. Then, an explanatory analysis was performed to clarify implicit messages of the text segments (STs), considering the most significant words of each class resulting from the software analysis. Details and procedures are discussed in the next section.

THE PROFILE OF THE ENTERPRISES INVESTIGATED

To carry out the analysis and investigation of the selected enterprises, the names of the enterprises were kept anonymous, using alphabetic letters to identify each business. Table 1 presents the projects.

Among the 20 projects selected, 12 (60%) were startups, and 8 (40%) identified themselves as NTBFs. To understand these typologies, during the interviews, the researcher explained the concepts of each type of company.

As for the age of the companies by the formal year of foundation, an average of 4 years and 6 months was observed, with the oldest having 11 years of existence and the youngest 2 years. As for the number of employees, including the founder(s), there are, on average, 13 employees per enterprise. The largest company had 112 employees, and the smallest had only one employee (the founder himself). The selected enterprises operate in different economic sectors, as seen in Table 1. Regarding the level of development of these businesses, 3 (15%) were in the Prototype/MVP testing phase in the market, 4 (20%) were in the market introduction phase, already generating revenue, and 13 (65%) were in the growth phase.

Observing the types of innovation, regarding their intensity, 16 (80%) enterprises developed incremental innovations, and 4 (20%) developed radical innovations. As for the object of innovation, 17 (85%) enterprises developed innovations in products or services, 2 (10%) focused on processes, and only 1 (5%) diversified innovations in products, services, and processes. As for size, considering annual gross revenue (Sebrae, 2019), it was observed that 8 (40%) were Microenterprises (annual revenue ≤ BRL 360,000.00); 7 (35%) were Small Businesses (EPP), with annual revenue > BRL 360,000.00 and < BRL 4,800,000.00; 4 (20%) were Individual Microentrepreneurs (MEI), with annual revenues ≤ BRL 81,000.00; and only 1 (5%) was a medium to a large company, with annual revenues ≥ BRL 4,800,000.00.

Table 1

Innovative enterprises investigated in the Brazilian Federal District

Code	Type	Age (years)	Industry	Innovative product or service
A	NTBF	3	Games	Games for entertainment and B2B market integrating augmented/virtual reality and networks
B	NTBF	4	Education	Platform for selling audio description services
C	NTBF	7	Industry	Fuel quality control tests
D	Startup	4	Services	Advertising platform for micro-entrepreneurs
E	NTBF	2	Education	Sustainable educational electricity kit
F	NTBF	8	Games	Game development
G	Startup	7	Automotive	Platform for vehicle mobility and maintenance
H	Startup	3	Events and Tourism	Digitalization of tourist experiences for micro and small companies and cooperatives
I	NTBF	11	Games	Author-focused digital experiences
J	Startup	3	Cloud computing	Document management system for automating document processes
K	Startup	3	Insurance	Insurance on demand
L	Startup	3	ICT and telecom	Blockchain-based integration of databases and distributed networks
M	NTBF	3	Construction	Development of technologies to improve construction processes
N	Startup	2	Hardware	Access management system for physical spaces in the cloud
O	Startup	4	Automotive	Platform to support the purchase of a car tailored to the user's needs
P	Startup	7	Management (Mining)	Mining process management
Q	Startup	2	Events and Tourism	Platform and community for connecting and empowering women travelers
R	Startup	5	Education	Technological independence for seniors
S	NTBF	8	Education	Technological platform for education
T	Startup	3	Finance	Marketplace for parcel does payments and contact organization

Note: Elaborated by the authors.

Significantly, 15 (75%) ventures were supported by innovation mechanisms, and only 5 (25%) did not have the same type of support. Among those that received support, 9 (60%) ventures had/have concomitant support from formal environments (e.g., accelerators, incubators, entrepreneurship and innovation hubs or centers, technology parks) as well as other support programs and platforms (e.g., projects public notices, competitions and innovation challenges aimed at the development of innovative businesses); 3 (20%) had/have support only from formal environments, and 3 (20%) had/have support only from other support programs and platforms. The Technological Development Center of the University of Brasilia (CDT/UnB) stands out as the main formal environment, with 6 of these undertakings linked currently or in previous years. Also noteworthy are the public notices promoted by the FAPDF for startups or innovative ventures, as the main program and support platform, with 4 of these projects contemplated in these notices.

Regarding investments, only 4 (30%) did not receive external contributions. Relevant part of the businesses - 14 (70%) - received external investments, of BRL 11,964,000.00. The highest investment received per project was BRL 3,000,000.00, and the lowest was BRL 50,000.00. Support programs and platforms stand out as the main source investing in 10 (50%) of the projects, with emphasis on the notices promoted by FAPDF for startups or innovative ventures, with 4 projects contemplated, and the notices of the Support Fund for Culture (FAC) BSB Multicultural with 3 developments contemplated. Angel investment, funds or venture capital, or monetary contribution from family and friends are listed as the other main sources indicated.

As for professional/business experience, it was observed that 18 (90%) enterprises had at least one of the founders with previous business experience, and only 2 (10%) did not have people with previous business experience. Finally, in the last category of the profile analysis, it can be seen that in the 20 (100%) enterprises observed, at least one founder had higher education, indicating the high qualification of the entrepreneurs.

RESULTS ANALYSIS

### Descending Hierarchical Classification (DHC): Subcorpus NTBFs

The analysis refers to textual statistics, Descending Hierarchical Classification (DHC) that allows a lexical analysis of the textual material, offering contexts (lexical classes) characterized by a specific vocabulary and by the segments of texts that share this vocabulary (Camargo, 2005; Camargo & Justo, 2013). The NTBFs subcorpus was composed of 8 different texts (the 8 interviews with the NTBFs), with a total of 24,449 occurrences in 3,052 different forms, considering the option for their lemmatization. Stemming is related to deflecting a word to determine its lemma (the inflections are called lexemes) (Salviati, 2017). The number of hapaxes observed was 1,488; 6.09% of occurrences were mentioned only once in the subcorpus. An hapax designates a word used or recorded only once in a corpus (Salviati, 2017). After the initial processing of the DHC by the IRAMUTEQ software, the set of 8 texts was divided into 693 different STs of approximately 3 lines. Only nouns were considered active forms in performing DHC.

Initially, DHC created the word dictionary. In this phase, the associative forces between words in the corpus and their classes were considered. To analyze these associative forces, the IRAMUTEQ software uses the chi-square test ($\chi 2 > 3.84$, $p < 0.05$) (Salviati, 2017). The classes presented below consider the initial context units (UCI), in this case, the 8 texts. In addition, they consider grouping elementary context units (ECU), in this case, the STs, according to observed occurrences. Only after processing and grouping according to UCI and UCE, the dendrogram of classes appears, as shown in Figure 1. The use of classes, in this study, demonstrates the groups of words whose association is statistically significant based on the chi-square test as latent themes about the investigated phenomenon, allowing the qualitative analysis of the data to be performed (Souza et al., 2018).

The dendrogram is read from left to right; the NTBFs subcorpus was initially divided into 2 other subcorpus. From the first, class 5 was obtained, with 23.4% of the total STs considered. The second subcorpus was divided again, forming classes 1, 22.2% of the total STs, and 4,12.6%. The second subcorpus also generated classes 2, with 17.7% of the STs, and 3, with 24.1% of the STs. From the STs and class segments of the dendrogram, in each case described, a list was created with words strongly associated with the class (Table 2). We opted for representing the 15 words with the highest levels of association to each class, from the value of $\chi 2 > 3.84$. The classes were also named to facilitate the understanding of the content.

Figure 1

Dendrogram of classes from the NTBFs subcorpus
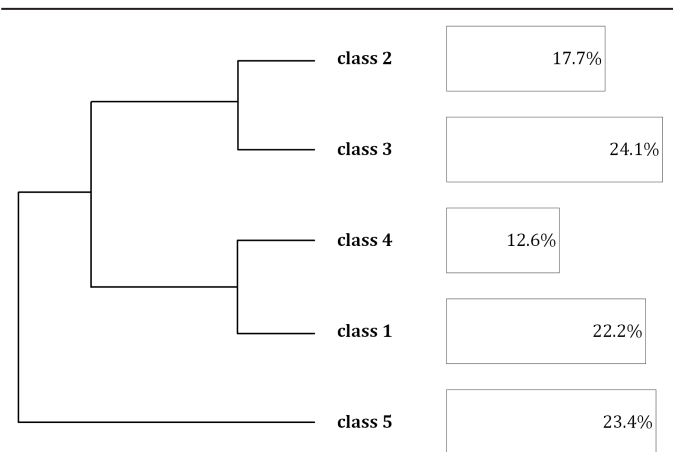
Note: Elaborated by the authors.

NTBFs subcorpus analysis revealed content grouping into 5 different classes or categories. Classes 5: Business Context and 1: Games industry detail the business contexts of the researched NTBFs. Specifically in class 5, 2 different contexts are presented in which the innovative product or service is inserted. At first, Construtech focused on "work" and "printing" in the "3D" style. The company focused on the "maker" culture aimed at the "children" public and the elaboration of more accessible electricity "kits" for teaching is also presented. Class 1 mostly addresses the context of the games industry, given that 3 of the 8 NTBFs participating in the research are part of this field. In this class, the functioning of the "games" "market" is emphasized, in addition to its "events" and "partnerships".

Classes 2, 3 and 4 detail the internal organization of companies. Class 4: Administration, addresses the mode of acquisition and use of different "resources", such as human, financial, and physical. It also details the role of the "experience" of "partners" and "founders" and the importance of "maturity" acquired by the company over time. Class 3: Acquisition and Maintenance of Knowledge, presents the main sources used by companies to acquire and manage knowledge necessary for innovation, emphasizing the importance of "meetings", "courses", "books" and "training". Finally, class 2: Production, addresses issues of "operation" and "production" with a focus on the "evolution" of the company and compliance with the "deadline", in addition to challenges involving the " production scale".

Descending Hierarchical Classification (DHC): Subcorpus startups

The startups subcorpus was composed of 12 different texts (the 12 interviews with the startups), with a total of 30,577 occurrences in 3,777 different forms, considering the option for their lemmatization. The number of hapaxes observed was 1,908; that is, 6.24% of occurrences were mentioned only once in the subcorpus. After the initial processing of the DHC by the IRAMUTEQ software, the set of 12 texts was divided into 865 different STs of approximately 3 lines. It was decided to use the dimensioning carried out in a standard way by the software itself to determine the extension of the STs. Verbs and nouns were considered active forms in the analyzes that make up the DHC given the need for greater semantic relevance for understanding the analyzed context.

Table 2

CHD from subcorpus NTBFs

Class 1: Industry of games	f (st)	χ2	Class 2: Production	f (st)	χ2	Class 3: Aquisition and maintenance of knowledge	f (st)	χ2	Class 4: Administration	f (st)	χ2	Class 5: Operatinal context	f (st)	χ2
game	44	83.2	service	18	80.3	meeting	15	29.3	partner	23	103.8	3D	22	69.6
time	13	33.2	product	34	76.7	year	21	26.2	human resource	10	62.5	kit	21	61.5
quite	18	30.1	need	6	28.2	turn	23	26.1	finacial resource	5	35.0	print	12	40.0
event	16	28.6	video	5	23.5	money	8	20.9	physical resource	5	35.0	maker	10	33.2
publishers	8	28.4	client	21	19.3	idea	13	18.9	founder	5	35.0	machine	10	28.4
company	41	26.3	month	7	19.1	internet	7	17.8	experience	11	35.0	prototype	8	26.5
marketplace	25	24.5	term	4	18.7	hour	5	15.8	term	8	32.5	movement	8	26.5
industry	13	21.9	operation	4	18.7	record	5	15.8	organization	4	27.9	access	11	24.3
step	6	21.2	evolution	5	17.9	course	13	15.2	infrastructure	4	27.9	potential	7	23.1
education	6	21.2	sale	9	16.8	notion	4	12.6	form	15	26.7	student	8	21.8
gamejam	5	17.6	tool	6	15.1	book	4	12.6	process	9	25.9	space	9	21.3
association	5	17.6	solution	4	13.4	panel	4	12.6	notice	6	24.3	pain	10	21.2
partnership	18	15.0	team	4	13.4	training	4	12.6	maturity	6	24.3	technology	16	20.2
partner	11	14.0	production scale	6	12.5	team	9	12.6	company	6	20.9	constructions	6	19.8
approximation	4	14.1	agency	3	9.1	barrier	7	11.7	administration	26	20.8	child	6	19.8

Note: f (st) represents the frequency of each word in the context of STs classified in classes. Elaborated by the authors.

After processing and grouping by IRAMUTEQ, according to UCI and UCE, the dendrogram of the classes was created, as shown in Figure 2. The dendrogram is read from left to right; the startups subcorpus was initially divided into other 2 subcorpus. From the first, class 6 was obtained, with 12.9% of the total STs considered. The second subcorpus was divided again, forming classes 1 and 2. The latter was responsible for 17.2% and 17.7% of the total STs, respectively. Classes 5, 3, and 4 were also generated, with 17%, 10.6%, and 24.7% of STs, respectively.

For each case described, a list of words most strongly associated with the classes was created (Table 3). We opted for representing the 15 words with thrash levels of association from the value of χ2>3.84. Names were given to the classesto facilitate the understanding of the content.

The startup's subcorpus analysis revealed the grouping of contents into 6 different classes/categories. Class 6: Trajectory and Context of Operation, details the history of startups and aspects of the "industry" tolerance of "media" for the development of the business, especially in the context of innovation in "tourism". Class 2 Fintech addresses startups in the financial sector with a focus on innovation in "payments" and relationships with "banks" and government "bodies". One issue raised in class discussions is the "security" of transactions as well as "cloud" data storage.

In Class 1: Administration, acquiring and maintaining "resources", especially financial and human resources, is addressed. The "FAPDF" is identified as one of the main sources of initial financial resources for business development. Class 5: Protection Mechanisms and Barriers, presents the difficulty and complexity of the process of creating "patents" as a way of "protecting" the "idea" or innovation offered by the company. Finally, classes 4: Partnerships and Knowledge Acquisition, and 5: Knowledge Maintenance, were generated. The first addresses the initial process of acquiring knowledge to innovate through different sources such as "university", "UnB" and "competing" companies themselves through the context of partnerships. The last one presents how the acquired "knowedge" is "absorbed". Emphasis was placed on the use of "methods", such as "scrum", in addition to the importance of "sharing" knowledge and information with "employees" so that "learning" occurs.

Figure 2

Dendrogram of classes from the Startups subcorpus
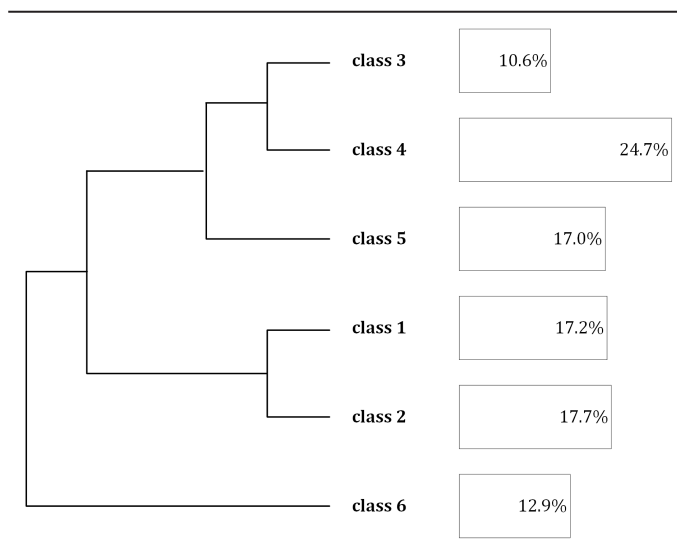
Note: Elaborated by the authors.

Content Analysis: Subcorpus NTBFs and Startups

Similarities and distinctions will be presented about the ACAP construct, observing the literature factors related to PACAP and RACAP, directed to the diffusion of innovation. The empirical evidence (EE) supports the interpretations according to each category of analysis.

Analysis 1: Relevant factors for acquiring and assimilating different types of absorbed knowledge related to PACAP

Organizational capacity - Classes 1 and 5 (Table 2) and 4 and 6 (Table 3) demonstrate the companies' technological trajectories. It was observed that the identification and assimilation of knowledge to innovate in NTBFs and startups led to a trajectory strongly linked

Table 3

DHC from the startups subcorpus

Class 1: Administration	f (st)	χ2	Class 2: Fintech	f (st)	χ2	Class 3: Knowledge maintenance	f (st)	χ2	Class 4: Partnerships and aquisition of knowledge	f (st)	χ2	Class 5: Protection mechanisms and barriers	f (st)	χ2	Class 6: Trajectory and context of operation	f (st)	χ2
city	12	46.9	pay	19	42.0	knowledge	33	89.6	project	19	29.8	sale	20	54.5	term	28	158.6
human resource	12	46.9	payment	11	40.6	cycle	10	75.9	company	53	27.1	sell	14	44.4	supplier	15	87.8
capital	9	43.7	sense	12	33.3	method	13	73.8	developer	12	25.1	application	15	33.8	tourism	9	61.5
money	15	41.2	environment	7	32.8	absorb	10	68.0	university	9	19.5	barrier	10	33.7	media	9	53.6
act	8	38.6	bank	10	28.2	vision	8	51.5	software	15	17.3	classroom	8	33.4	industry	7	47.7
finacial resource	11	30.4	agency	6	28.1	to apply	7	43.3	search	7	17.1	to teach	6	29.5	user experience	7	47.7
income	6	29.0	server	6	28.1	apprenticeship	7	37.7	signature	7	17.1	telephone	7	28.5	improvement	6	40.8
to knock	6	29.0	to enter	12	25.2	to obtain	6	35.3	start	11	17.0	to help	16	24.2	aspect	6	40.8
to place	22	28.0	security	10	25.1	scrum	4	33.9	delivery	8	16.6	to transform	7	23.8	to feel	7	40.1
bankrupt	7	28..0	cloud	11	23.8	to share	4	33.9	technician	5	15.3	protect	66	23.6	conversation	5	34.0
person	40	26.8	condition	5	23.4	base	6	30.2	phase	5	15.3	day	11	21.0	campaign	5	34.0
level	9	25.0	innovation	22	23.0	to develop	16	30.1	world	17	14.5	idea	20	21.0	register	6	27.7
require	5	24.2	marketplace	30	202	plan	5	27.6	to know	10	14.5	patent	4	19.6	platform	16	27.5
expertise	7	23.4	diffcicult	17	20.0	innovate	8	26.7	UnB	6	14.1	student	4	19.6	announcement	4	27.2
founder	7	23.4	event	4	18.7	collaborator	7	26.1	competitor	8	13.8	to break	6	19.3	tourist	4	27.2

Note: f (st) represents the frequency of each word in the context of STs classified in classes. Elaborated by the authors.

to partnerships. For example, we highlight the environment of universities, research and extension projects, external knowledge from companies in the same industry, inter-organizational partnerships, and events in the area of expertise. Despite this similarity, the assimilation of the knowledge necessary to innovate had more variability in startups. This result aligns with Malik and Wei (2011) and Aribi and Dupouët (2015), who propose that organizational structures, which allow external partnerships, help enterprises become more innovative and competitive.

> EE (Company E): It was something I was already developing. A few 3D printing prototypes and I had already experienced that pain. I was doing an extension project at the university, and we taught electronics to public schools there. The student branch project sought to strengthen relations between the public school and the university.

Innovation Openness - A high level of openness to innovation and obtaining knowledge from sources outside the NTBFs and startups analyzed was observed. In addition to inter-organizational partnerships and mentoring, the role of the customer in improving the product/service offered was highlighted. Malik and Wei (2011) and Garengo (2019) indicate that customers or other organizations can extend a company's internal knowledge and resources to create innovations to achieve marketing success

> EE (Company J): Technology partners are a key point. Today we have a partnership with Microsoft, with Adobe, and when you bring a partner, it allows you to accelerate your technology. Imagine if I needed to build everything from scratch? Never that the product would be on the air! When you bring in a partner, you speed up your road map.

Social capital, networks, and partnerships - Considering other partnerships, networks and innovation support environments, there was a frequent report of support from the University of Brasília (UnB) and other universities, in addition to the innovation support environment - the CDT/UnB. FAPDF was cited as the main supporter of initial financial resources. Commercial partnerships with large corporations, such as Microsoft, help to attract customers

interested in the technologies offered. Both NTBFs and startups have similarly benefited from external partnerships, networks, and innovation support environments. This demonstrates that they were positively influenced by various forms of knowledge dissemination that helped in strategic decisions regarding information, research, and development, as proposed by Cuvero et al. (2019).

> EE (Company N): We always relied on the university, on UnB, to carry out the research part. Both for our background, which is engineering formed by UnB and going directly to the professors, for us to partner with the laboratory, to be able to execute the project.

Means of acquiring knowledge - In addition to the means already mentioned, some companies mentioned others, such as contact with startups that have been in the market for a longer time, feedback from suppliers, readings, training, and contact with researchers in funded research. The representative of a NTBF reported that he gained learning through the company's unsuccessful internationalization attempt, while the representative of a startup reported that his motivation to learn enabled the acquisition of new knowledge. The less known or more innovative the area of expertise, the greater the difficulty in establishing partnerships and acquiring external knowledge. The heterogeneity of knowledge sources, resources and cognitive distance between partners, as well as adaptation to the environment and internationalization experiences, converged with Nooteboom et al. (2007) and Zheng et al. (2010).

Capacity for knowledge acquisition, development, and management - Observing the results obtained in class 3 (Table 2 and Table 3), there was a distinction between NTBFs and startups in managing knowledge. NTBFs do not seem to have specific methods or more formal procedures to organize absorbed knowledge. Most startups in the survey claimed to have a knowledge repository with records of procedures, documentation, tasks, and other technical information; they also use agile, scrum, and Kanban methods. Such management methods, mainly adopted by startups, are aligned with internal knowledge dissemination and sharing methods to generate innovation (Aribi & Dupouët, 2015; Garengo, 2019).

Capacity for learning - Information about learning capacity was found in class 3 (Table 2 and Table 3). Representatives of NTBFs and startups mentioned the need for continuous updating and the search for knowledge through training and studies on the market and innovation. In NTBFs, it was observed that being updated on the international context is important when mentioning international partnerships in the same field or participating in international activities. NTBFs differ from startups regarding their focus on studies on the international market. Preparing these companies through the learning process for internationalization makes them more innovative and competitive (Malik & Wei, 2011; Sheng & Chien, 2016).

> EE (Company K): It's a daily learning experience. Nowadays, we have a policy of studying, of courses, acquiring knowledge, and stimulating people. Sometimes we even take hours of work out of the day to dedicate to the study of new technologies, new tools, and new processes. Everyone is studying all the time.

Capacity to use organizational resources - In classes 4 and 1 (Table 2 and Table 3) the results showed two ways of using resources: based on own resources and external investment. NTBFs and startups showed similarities. The growth process is more collaborative when the company develops from its resources. Based on external investment, the second scenario is represented by support from development agencies such as FAPDF and angel investors. Nevertheless, the financial resources provided by FAPDF played an important role in the initial development of nascent companies. In NTBFs and startups, most of the financial resources were used to hire people and develop innovative products/services. Part of the financial resource is directed toward digital marketing. Both types of undertakings show the ability to manage resources as a critical development activity. Despite limited resources, good management contributed to innovations and marketing success, corroborating reflections by Wang et al. (2016) and Garengo (2019).

> EE (Company M): This investment came a lot in this part of the physical space for company maintenance. I think we should invest more in people, in human resources, than we invested, but it's really because we didn't have that many financial resources to do that.

Relevant factors for transformation and exploitation of knowledge for the diffusion of innovation related to RACAP

Human capital for innovation - Asked about the previous experience of the founders and/or team, the interviewees reported previous incipient and basic experiences. Nevertheless, NTBFs, in general, started the company within the academic/university context. In startups, however, it was more frequent to report that partners and founders had previous professional experience, in addition to knowledge of the market, which corroborates the discussions made by Wang et al. (2016) and Larrañeta et al. (2017), in which the experience to innovate involves previous professional and academic knowledge, benefiting the development of innovations.

RD&I Capacity – Universities (e.g., UnB) were the main sources of knowledge and initial partnership for companies to develop innovative product prototypes and partnerships with players in the same market. Among the external partnerships that favored the RD&I capacity, the laboratories for assembling prototypes and carrying out tests stand out. Such results are associated with technological capabilities with external collaborations, as discussed by Burcharth et al. (2015) and Ubeda et al. (2019), whose partnerships with RD&I are key sources for obtaining knowledge and capabilities.

> EE (Company N): It was very important to have a partnership with FabLaB. We had a very close partnership with them because they had the machines that we used to prototype.

Technological capacity - In the results presented in Class 2 (Table 2), the reports suggested the good condition of the companies. NTBFs and startups assessed that they have the technical and technological capacity to do whatever is necessary to develop the innovative product/service offered. It should be noted that the limitation of financial resources prevents greater technological capacity, revealing the importance of partnerships to increase this capacity. However, NTBFs and startups realize the importance of technological capability and invest resources to develop it. These enterprises showed good pre-existing knowledge, seeking partnerships to leverage complementary skills to innovate, corroborating Wang et al. (2016) and Hötte (2020).

> EE (Company J): The technological capacity is great. What is difficult today is the financial capacity itself, the road map.

Protection of knowledge, technology, innovation, and appropriability - Information on protection mechanisms used by the companies analyzed can be found in class 5 (Table 3), which brings a vision shared by NTBFs and startups, which is that the process of patent via the National Institute of Industrial Property (INPI) is expensive and slow, discouraging them from seeking this protection. The pioneering strategy in the market and quick launches are perceived as strategies that guarantee some protection. The NTBFs highlighted the difficulty in carrying out innovation protection processes via formal incubation environments, as they claim that there is no necessary agility in the process. In addition to the information posted, a performance pattern that differentiates NTBFs from startups was not identified. Such appropriability and technology protection strategies reveal other means adopted, different from traditional means of protection, such as intellectual or industrial property, converging with considerations by Li et al. (2015).

> EE (Company N): Our focus is mainly on this protection for software. We do not believe in legal protection via patent or registration of software. We don't use this type of protection nowadays because we think it's not interesting. We only use trademark protection via INPI.

Capacity to generate innovation results through market introduction channels - A difference observed about market introduction was the emphasis that startups placed on the power of the media and Press offices in leveraging the business. Social networks are also widely used to advertise products/services. In the NTBFs, however, no salient pattern/factor was identified that determined the results of the marketing introduction. NTBFs presented varied introduction strategies, such as crowdfunding and sweepstakes, or even the lack of more elaborate strategies. In this category, startups showed greater knowledge about adequate and relevant mechanisms for the diffusion of innovation (Barnett et al., 2011).

Capacity to generate innovation results through new technologies and financial investments - NTBFs and startups reported the democratization of access to resources for development, in addition to the current maturity of the market for digital technologies and innovation. Identifying possibilities quickly as changes occur in the external environment is an essential skill for startup and NTBFs. In addition, they reported that access to external financial resources, from public notices and development agencies, facilitates the development and introduction of innovation in the market. Such results demonstrated that the facilitated access to new technologies, and investment in market development, provided structures and means for increasing the diffusion of innovation (Wang et al., 2016).

EE (Company H): The essential factor for me to be able to introduce the company to the market was the initial financial resource so that I could structure the minimum and, from there create a point of development.

Capacity to generate innovation results related to market introduction barriers – Market entry barriers are found in classes 3 and 5 (Table 2 and Table 3). Only NTBFs reported the production scale as a barrier to introducing innovation to the market. Lack of financial investment and little government incentive were pointed out as limiting innovation. This limitation slows growth and investment in human capital and physical resources. It should be noted that while NTBFs emphasized the production scale factor, the government factor was more emphasized by startups. For Barnett et al., (2011) and Cuvero et al. (2019), the barriers pointed out by the enterprises hinder the creation and dissemination of innovation, mainly related to the speed of dissemination of innovation in the market.

EE (Company G): Money because money will allow you to progress. Here in Brazil, you can't make mistakes, you can't stand it. Nobody can stand.

Table 4, summarizes the main results of the analysis, with a description of similarities or differences between NTBFs and startups related to critical factors for the occurrence of ACAP and the diffusion of innovation.

CONCLUSIONS

This study aimed to elucidate the context, relationship, and contribution of Absorptive Capacity (ACAP) to the diffusion of innovations in NTBFs and startups in the Brazilian Federal District. Based on theory and empirical evidence, it was observed that factors for the development of absorptive capacity related to PACAP act as antecedents of the diffusion of innovation in converting knowledge into innovation. Factors associated with RACAP influence the diffusion of innovation, emphasizing the ability to generate innovation results through marketing channels, new technologies, and financial investments.

The ACAP factors identified and categorized according to the literature proved to be relevant for both cases, whether due to similarities or differences between NTBFs and startups. It is expected that the research results will broaden the understanding of the relationship between ACAP and the diffusion of innovation, involving the absorption of knowledge and the dynamics of these constructs in specific contexts, such as in NTBFs and startups.

The research seeks to contribute to the theoretical field, which still lacks, especially regional production on the relationship between ACAP constructs and the diffusion of innovation in innovative enterprises, such as in the Brazilian Federal District. The research broadens the understanding of this relationship, involving the absorption of knowledge and the dynamics of these constructs through critical factors in specific contexts that are still little investigated, such as NTBFs and startups.

The research has managerial implications for the practices of these enterprises, as well as for the planning, development, or strengthening of innovation support programs. Innovation environments such as business incubators, accelerators, and other innovative entrepreneurship hubs can gain insights to improve the support offered. The critical factors for the development of ACAP and the diffusion of innovation in NTBFs and startups enable a better understanding of innovation processes integrated into enterprises' journey. Identifying factors with their descriptions, occurrences, examples and empirical evidence can provide a better fit to the needs of NTBFs and startups in incubation and

Table 4

Synthesis of similarities or differences between NTBFs and startups related to the occurrence of ACAP towards the diffusion of innovation

	Factors related to ACAP dimensions	Main results
	Organizacional capacity	NTBFs and startups have a trajectory strongly linked to partnerships. Startups with more variability.
	Innovation openness	NTBFs and startups with high openness to obtain knowledge, partnerships, mentorships and clients.
P	Social capital, networks, partnerships, and cognitive capacity	NTBFs have greater links with universities. Startups have greater proximity to commercial partnerships with large companies.
A	Means of acquiring knowledge	NTBFs and startups absorb feedback from suppliers, readings, trainning and contact with researchers.
C		
A	Capacity for knowledge acquisition, development, and management	NTBFs use more traditional means of management. Startups use digital management processes with an emphasis on management tools.
P		
	Capacity for learning	NTBFs and startups update and improve knowledge through courses, training, and market studies. NTBFs emphasize more internationalization processes.
	Capacity to use organizational resources	NTBFs and startups promote more external collaborations when using their own resources. Both focus on HR and R&D.
	Human capital for innovation	NTBFs have greater academic experience. Startups have greater business experience.
	RD&I capacity	NTBFs use universities more as main sources of support for RD&I. Startups focus more on market partners, mainly for prototyping.
	Technological capacity	NTBFs and startups have good technology, seeking partnerships to complement capabilities.
R	Protection of knowledge, technology, innovation, and appropriability	NTBFs and startups perceive industrial and intellectual property processes as expensive and slow, using market protection and appropriability.
A		
C	Capacity to generate innovation results through market introduction channels	NTBFs adhere to traditional means of diffusion. Startups have greater links with the media and new tools with a broader range of marketing introduction strategies.
A		
P	Capacity to generate innovation results through new technologies and financial investments	NTBFs and startups point to similar factors that ingluence innovation results, such as technological democratization, digital market maturity, and government finance support.
	Capacity to generate innovation results related to market introduction barriers	NTBFs and startups indicate lack of investments as the main development barrier. NTBFs additionally, point to the production scale. Startups point to government support.

Note: Elaborated by the authors.

acceleration processes, involving antecedent factors linked to PACAP, development processes, and the diffusion of innovation with greater focus on RACAP.

The study corroborates the importance and potential of policies to support technological innovation to plan and implement more effective mechanisms to encourage technological development and innovative entrepreneurship in regional contexts. From the analyses, it was possible to verify specificities related to the types of enterprises investigated. This can lead to different levels or segmentations of support programs or policies that are intended to be instituted with greater assertiveness about the needs based on the profile of these enterprises.

As a limitation of the study, the approach given to the types of innovation identified stands out since the study did not analyze the impact of ACAP on the different types of innovation. Future studies could investigate such typologies as a relevant variable related to the PACAP and RACAP factors that lead to the absorption capacity and diffusion of innovation since different types of innovation demand

different processes or ways of innovating. Another limitation refers to the methodology, as the quantitative approach would involve a large sample, allowing for greater representativeness and variability of results and enabling the analysis of factors that can be converted into conceptual models with innovation as a result ACAP processes.

The profile of the enterprises studied opens new investigations exploring the different capacities required to innovate. Operating sectors, differences in the level of maturity of the enterprises, strategic positioning in the market and in the ecosystem in which they are inserted, types of partnerships, and greater detail on the types of support and resources obtained through external alliances, should be better explored. Studies that prioritize such specificities would improve the understanding of how different resources and strategies influence the occurrence of ACAP and how these enterprises spread their innovations. Finally, to what extent can NTBFs and startups gain more space in the DF regional ecosystem in the coming years, or what challenges, opportunities, and impacts of the current context or associated with the recent impact of COVID-19 to the diffusion of innovation in these ventures, are pertinent questions that require further investigation.

Conflict of interest statement

The authors declare that does not exist an interest conflict.

Authors' statement of individual contributions

Roles	Contributions per author	
	Pereira BA	Farias JS
Conceptualization	■	■
Methodology	■	■
Software	■	
Validation	■	■
Formal analysis	■	■
Investigation	■	
Resources	■	■
Data Curation	■	■
Writing - Original Draft	■	■
Writing - Review & Editing		
Visualization	■	■
Supervision		
Project administration	■	■
Funding acquistion	N.A.	

REFERENCES

ABStartups - Associação Brasileira de Startups. (2019). *Associação Brasileira de Startups: Mapeamento de Comunidades região Centro-Oeste*. https://abstartups.com.br/mapeamento-Centro-Oeste/

Anatoliivna, V. O. (2013). Absorptive capacity in organizational theories: Learning, innovation, managerial cognition. *Marketing & Management of Innovations*, 4, 190-199. https://doi.org/10.21272/mmi.2013.4-18

Aribi, A., & Dupouët, O. (2015). The role of organizational and social capital in the firm's absorptive capacity. *Journal of Knowledge Management*, 19(5), 987-1006. https://doi.org/10.1108/JKM-05-2015-0169

Bardin, L (1977). Análise de conteúdo. Lisboa: Edições.

Barnett, J., Vasileiou, K., Djemil, F., Brooks, L., & Young, T. (2011). Understanding innovators' experiences of barriers and facilitators in implementation and diffusion of healthcare service innovations: A qualitative study. *BMC Health Services Research*, 11(1), 342-342. https://doi.org/10.1186/1472-6963-11-342

Benson, D., & Ziedonis, R. H. (2009). Corporate Venture Capital as a Window on New Technologies: Implications for the Performance of Corporate Investors When Acquiring Startups. *Organization Science*, 20(2), 329-351. https://doi.org/10.1287/orsc.1080.0386

Blank, S., & Dorf, B. (2012). The step-by-step guide for building a great company. Pescadero, Calif: K&S Ranch, Inc.

Burcharth, A. L. L. A., Lettl, C., & Ulhøi, J. P. (2015). Extending organizational antecedents of absorptive capacity: Organizational characteristics that encourage experimentation. *Technological Forecasting and Social Change*, 90, 269-284. https://doi.org/10.1016/j.techfore.2013.12.024

Camargo, B. V. (2005). ALCESTE: Um programa informático de análise quantitativa de dados textuais. In A. S. P. Moreira, B. V. Camargo, J. C. Jesuíno, & S. M. Nóbrega (Eds.), *Perspectivas teórico-metodológicas em representações sociais* (pp. 511-539). João Pessoa, PB: Editora da Universidade Federal da Paraíba.

Camargo, B. V., & Justo, A. M. (2013). IRAMUTEQ: um software gratuito para análise de dados textuais. *Temas em Psicologia*, 21(2), 513-518. https://doi.org/10.9788/TP2013.2-16

Camisón, C., & Forés, B. (2010). Knowledge absorptive capacity: New insights for its conceptualization and measurement. *Journal of Business Research*, 63(7), 707-715. https://doi.org/10.1016/j.jbusres.2009.04.022

Chung, D., Jung, H., & Lee, Y. (2021). Investigating the relationship of high-tech entrepreneurship and innovation efficacy: The moderating role of absorptive capacity. *Technovation*, 111, 102393. https://doi.org/10.1016/j.technovation.2021.102393

Cohen, W., & Levinthal, D. (1990). Absorptive Capacity: A New Perspective on Learning and Innovation. *Administrative Science Quarterly*, 35(1), 128-152. https://doi.org/10.2307/2393553

Cuvero, M., Granados, M. L., Pilkington, A., & Evans, R. D. (2019). The effects of knowledge spillovers and accelerator programs on the product innovation of high-tech startups: A multiple case study. *IEEE Transactions on Engineering Management*, 1-14. https://doi.org/10.1109/TEM.2019.2923250

Dabic, M., Vlacic, E., Ramanathan, U., & Egri, C. P. (2020). Evolving absorptive capacity: The mediating role of systematic knowledge management. *IEEE Transactions on Engineering Management*, 67(3), 783-793. https://doi.org/10.1109/TEM.2019.2893133

Deeds, D. L. (2001). The role of P&D intensity, technical development and absorptive capacity in creating entrepreneurial wealth in high technology startups. *Journal of Engineering and Technology Management*, 18(1), 29-47. https://doi.org/10.1016/S0923-4748(00)00032-1

Flechas Chaparro, X. A., Kozesinski, R., & Salles Camargo Júnior, A. (2021). Absorptive capacity in startups: A Systematic literature review. *Journal of Entrepreneurship, Management and Innovation*, 17(1), 57-95. https://doi.org/10.7341/20211712

Flor, M. L., Cooper, S. Y., & Oltra, M. J. (2017). External knowledge search, absorptive capacity and radical innovation in high-technology firms. *European Management Journal*, 1-12. https://doi.org/10.1016/j.emj.2017.08.003

Fontanella, B. J. B., Luchesi, B. M., Saidel, M. G. B., Ricas, J., Turato, E. R., & Melo, D. G. (2011). Amostragem em pesquisas qualitativas: proposta de procedimentos para constatar saturação teórica. *Cadernos de Saúde Pública*, 27(2), 388-394. https://doi.org/10.1590/S0102-311X2011000200020

Fukugawa, N. (2013). University spillovers into small technology-based firms: channel, mechanism, and geography. J*ournal of Technology Transfer*, 38(4), 415-431. https://doi.org/10.1007/s10961-012-9247-x

Garengo, P. (2019). How bridging organisations manage technology transfer in SMEs: An empirical investigation. *Technology Analysis & Strategic Management*, 31(4), 477-491. https://doi.org/10.1080/09537325.2018.1520976

Ho, H., Osiyevskyy, O., Agarwal, J., & Reza, S. (2020). Does ambidexterity in marketing pay off? The role of absorptive capacity. *Journal of Business Research,* 110, 65-79. https://doi.org/10.1016/j.jbusres.2019.12.050

Hötte, K. (2020). How to accelerate green technology diffusion? directed technological change in the presence of coevolving absorptive capacity. *Energy Economics*, 85, 104565. https://doi.org/10.1016/j.eneco.2019.104565

Hughes, P., Hodgkinson, I. R., Hughes, M., & Arshad, D. (2017). Explaining the entrepreneurial orientation–performance relationship in emerging economies: The intermediate roles of absorptive capacity and improvisation. *Asia Pacific Journal of Management*, 1-29. https://doi.org/10.1007/S10490-017-9539-7

Jantunen, A. (2005). Knowledge-processing capabilities and innovative performance: an empirical study. *European Journal of Innovation Management*, 8(3), 336-349. https://doi.org/10.1108/14601060510610199

Kato, M. (2020). Founders' human capital and external knowledge sourcing: Exploring the absorptive capacity of startup firms. *Economics of Innovation and New Technology*, 29(2), 184-205. https://doi.org/10.1080/10438599.2019.1598670

Larrañeta, B., Galán González, J. L., & Aguilar, R. (2017). Early efforts to develop absorptive capacity and their performance implications: differences among corporate and independent ventures. *The Journal of Technology Transfer*, 42(3), 485-509. https://doi.org/10.1007/s10961-016-9488-1

Li, Y., Youtie, J., & Shapira, P. (2015). Why do technology firms publish scientific papers? The strategic use of science by small and midsize enterprises in nanotechnology. *The Journal of Technology Transfer*, 40, 1016. https://doi.org/10.1007/s10961-014-9391-6

Lindelöf, P., & Löfsten, H. (2003). Science park location and new technology-based firms in Sweden–implications for strategy and performance. *Small Business Economics*, 20(3), 245-258. https://doi.org/10.1023/A:1022861823493

Luo, B. N., Lui, S. S., & Kim, Y. (2017). Revisiting the relationship between knowledge search breadth and firm innovation: A knowledge transfer perspective. *Management Decision*, 55(1), 2-14. https://doi.org/10.1108/MD-07-2015-0327

Malik, K., & Wei, J. (2011). How external partnering enhances innovation: evidence from Chinese technology-based SMEs. *Technology Analysis & Strategic Management*, 23(4), 401-413. https://doi.org/10.1080/09537325.2011.558398

Marcon, A., & Ribeiro J. L. D. (2021). How do startups manage external resources in innovation ecosystems? A resource perspective of startups' lifecycle. *Technological Forecasting and Social Change*, 171, 120965. https://doi.org/10.1016/j.techfore.2021.120965

Mason, G., Rincon-Aznar, A., & Venturini, F. (2020). Which skills contribute most to absorptive capacity, innovation and productivity performance? Evidence from the US and Western Europe. *Economics of Innovation and New Technology*, 29(3), 223-241. https://doi.org/10.1080/10438599.2019.1610547

Motohashi, K. (2005). University–industry collaborations in Japan: The role of new technology-based firms in transforming the National Innovation System. *Research Policy*, 34:, 583-594. https://doi.org/10.1016/j.respol.2005.03.001

Nooteboom, B., Van Haverbeke, W., Duysters, G., Gilsing, V., & Van den Oord, A. (2007). Optimal cognitive distance and absorptive capacity. *Research Policy*, 36(7), 1016-1034. https://doi.org/10.1016/j.respol.2007.04.003

Mueller, P. (2007). Exploiting entrepreneurial opportunities: The impact of entrepreneurship on growth. *Small Business Economics*, 28(4), 355-362. https://doi.org/10.1007/s11187-006-9035-9

Rogers, E. M. (1983). Diffusion of innovations. New York: The Free Press.

Rothaermel, F. T., & Thursby, M. (2005). University–incubator firm knowledge flows: assessing their impact on incubator firm performance. *Research Policy*, 34(3), 305-320. https://doi.org/10.1016/j.respol.2004.11.006

Salviati, M. (2017). *Manual do Aplicativo Iramuteq* (versão 0.7 Alpha 2 e R Versão 3.2.3). http://www.iramuteq.org/documentation/fichiers/manual-do-aplicativo-iramuteq-par-maria-elisabeth-salviati

Sebrae - Serviço Brasileiro de Apoio às Micro e Pequenas Empresas (2019). *Confira as diferenças entre microempresa, pequena empresa e MEI*. https://www.sebrae.com.br/sites/PortalSebrae/artigos/entenda-as-diferencas-entre-microempresa-pequena-empresa-e-mei,03f5438af1c92410VgnVCM100000b272010aRCRD

Serrano-Bedia, A. M., López-Fernández, M. C., & García-Piqueres, G. (2012). Complementarity between innovation activities and innovation performance: Evidence from Spanish innovative firms. *Journal of Manufacturing Technology Management*, 23(5), 557-577. https://doi.org/10.1108/17410381211234408

Sheng, M. L., & Chien, I. (2016). Rethinking organizational learning orientation on radical and incremental innovation in high-tech firms. *Journal of Business Research*, 69(6), 2302-2308. https://doi.org/10.1016/j.jbusres.2015.12.046

Souza, M. A. R., Wall, M. L., Thuler, A. C. M. C., Lowen, I. M. V., & Peres, A. M. (2018). O uso do software IRAMUTEQ na análise de dados em pesquisas qualitativas. *Revista da Escola de Enfermagem da USP*; 52. http://dx.doi.org/10.1590/S1980-220X2017015003353

Teigland, R., Gangi, P. M., Flåten, B., Giovacchini, B., & Pastorino, N. (2014). Balancing on a tightrope: Managing the boundaries of a firm-sponsored OSS community and its impact on innovation and absorptive capacity. *Information and Organization*, 24(1), 25-47. https://doi.org/10.1016/j.infoandorg.2014.01.001

Ubeda, F. M., Ortiz-de-Urbina-Criado, M., & Mora-Valentín, E. (2019). Do firms located in science and technology parks enhance innovation performance? The effect of absorptive capacity. *The Journal of Technology Transfer*, 44(1), 21-48. https://doi.org/10.1007/s10961-018-9686-0

Veugelers, R., & Cassiman, B. (1999). Make and buy in innovation strategies: evidence from Belgian manufacturing firms. *Research Policy*, 28(1), 63-80. https://doi.org/10.1016/S0048-7333(98)00106-1

von Briel, F., Schneider, C., & Lowry, P. B. (2019). Absorbing Knowledge from and with External Partners: The Role of Social Integration Mechanisms. *Decision Science*, 50(1), 7-45. https://doi.org/10.1111/deci.12314

Wang, Z., Wang, Q., Zhao, X., Lyles, M. A., & Zhu, G. (2016). Interactive effects of external knowledge sources and internal resources on the innovation capability of Chinese manufacturers. *Industrial Management & Data Systems*, 116(8), 1617-1635. https://doi.org/10.1108/IMDS-10-2015-0412

Yang, D., Li, L., Jiang, X., & Zhao, J. (2019). The fit between market learning and organizational capabilities for management innovation. *Industrial Marketing Management*, 86, 223-232. https://doi.org/10.1016/j.indmarman.2019.12.007

Zahra S. A., & George, G. (2002). Absorptive capacity: a review, reconceptualization, and extension. *Academy of Management Review*, 27, 185-203. https://doi.org/10.2307/4134351

Zheng, Y., Liu, J., & George, G. (2010). The dynamic impact of innovative capability and inter-firm network on firm valuation: A longitudinal study of biotechnology startups. *Journal of Business Venturing*, 25(6), 593-60. https://doi.org/10.1016/j.jbusvent.2009.02.001

AUTHOR BIOGRAPHIES

Bruno Alencar Pereira *is a lecturer and researcher in entrepreneurship and innovation at the College of Business, Government and Law at Flinders University, Adelaide, Australia. He holds a Doctorate from the University of Brasília, a Master's from the Federal University of Goiás, a Specialization from Underp-UniAnhanguera and a Graduation from Faculdade Anhanguera de Anápolis. His areas of interest include Entrepreneurship, Innovation and Industry Transformation. He is a member of the Australian Industrial Transformation Institute and the Australian Computer Society.*

E-mail: bruno.pereira@flinders.edu.au

Josivania Silva Farias *is an Associate Professor at the Universidade de Brasília (UnB), in the Administration Department. Professor of Undergraduate course (ADM/UnB) and the Graduate / Post-graduate Program in Administration (PPGA/UnB), Federal District, Brazil. She holds a Doctorate from the University of Brasília, Postdoctoral Internship as a visiting researcher at the Universidad Complutense de Madrid, Masters, Specialization, and Graduation from the Federal University of Sergipe, and an MBA from the Getúlio Vargas Foundation (RJ). Her areas of interest include Administration, with an emphasis on Service Marketing and Service Innovation (in the public and private sector). She is leader of the Research Group: LInseLab-Laboratory of Studies and Research on Innovation and Services, certified by CNPq.*

E-mail: josivania@unb.br

APPENDIX A

Researcher interview script

The absorptive capacity and the diffusion of innovation in NTBFs and startups: A study in the Brazilian Federal District

PART 1 - Enterprise profile and innovation typologies

Question
1. Name of the enterprise:
2. City; State; Country where the enterprise is located:
3. Scope of action of the enterprise: ( ) Local ( ) Regional ( ) National ( ) International
4. How old is the company?
5. Operations field of the enterprise*: ( ) Advertising ( ) Agribusiness ( ) Automotive ( ) Big Data ( ) Biotechnology ( ) CRM ( ) Home and Family ( ) Cloud Computing ( ) Communication and Media ( ) Civil Construction ( ) Software Development ( ) Law ( ) E-commerce ( ) Education ( ) Energy ( ) Entertainment ( ) Sports ( ) Events and Tourism ( ) Finance ( ) Games ( ) Management ( ) Hardware ( ) Real Estate ( ) Industry ( ) Children ( ) Internet ( ) Logistics and Urban Mobility ( ) Environment ( ) Mobile ( ) Fashion and Beauty ( ) Nanotechnology ( ) Pets ( ) Consumer Products ( ) Recruitment ( ) Human Resources ( ) Health and Wellbeing ( ) Security and Defense ( ) Insurance ( ) Professional Services ( ) ICT and Telecom ( ) Transport ( ) Retail / Wholesale ( ) Sales and Marketing ( ) Video *Source: StartupBase (2019)*
6. Describe the main innovative product/service sold by the enterprise:
7. What level of development would you indicate for your venture/solution? ( ) Idea/Early-stage ( ) Prototype/MVP ( ) Market introduction ( ) Growth ( ) Maturity
8. Year of introduction of the innovative product/service on the market:
9. In your opinion, how would you indicate the type of innovation they develop and commercialize?* Regarding the intensity: ( ) Innovation has transformed existing markets or created new markets, revolutionizing the use and performance of existing products/services. (radical) or ( ) Innovation was based on improvements that provided new features or new benefits for technology or solution existing in the market. (incremental) Regarding the object: Innovation is related to: ( ) Product or Service ( ) Process ( ) Marketing ** In terms of typologies, innovations are generally categorized as incremental or radical innovation (in terms of intensity) and product, service, process or marketing innovation (in terms of object) (Oke, 2007; Kurt et al., 2013; Niine et al. al., 2015; OECD, 2018). Radical or disruptive innovation involves products, services or approaches that transform existing markets or create new ones, turning the original use and performance into a significant change in terms of simplicity, convenience, accessibility and accessibility (Oke, 2007; Kurt et al., 2013; Gemici & Alpkan, 2015; Niine et al., 2015; OECD, 2018). Incremental innovations can be defined as products, services, organizational and marketing improvements that provide new features or new benefits to the existing technology or solution in the current market (Oke, 2007; Kurt et al., 2013; Garcia & Calantone, 2002; OECD, 2018).*
10. What is the size of the enterprise in terms of annual gross revenue?* ( ) Individual Microentrepreneur (MEI) ( ) Microenterprise ( ) Small Business ( ) Medium to Large Company **Size: Individual Microentrepreneur (MEI) - equal to or less than R$81,000.00. Microenterprise - equal to or less than R$360,000.00. Small Business (EPP) - greater than R$360,000.00 and less than R$4,800,000.00. Medium to Large Company - equal to or greater than R$4,800,000.00. Source: SEBRAE (2019).*
11. Current number of employees, including founder(s) working in the venture:
12. Do you receive or received support from any support mechanism? Answer: ( ) Yes ( ) No
13. If yes. What support mechanism? ( ) Formal support environments: accelerators, incubators, entrepreneurship and innovation hubs or centers, technology parks, etc. ( ) Programs and support platforms: projects, notices, competitions and innovation challenges aimed at developing innovative businesses, etc.
14. Did you receive external investment (financial)? Answer: ( ) Yes ( ) No
15. If yes. What is the total amount of investment(s) received?
16. If yes. What is the major source of investment(s)? ( ) Family/Friends ( ) Angel ( ) Formal support environments: accelerators, incubators, entrepreneurship and innovation hubs or centers, technology parks, etc. ( ) Programs and support platforms: projects, notices, competitions and innovation challenges aimed at developing innovative businesses, etc. ( ) Investment Funds/Venture Capital ( ) Others
17. Did the founder(s) have previous business experience? Answer: ( ) Yes ( ) No
18. Does at least one founder have higher education? Answer: ( ) Yes ( ) No

PART 2 – Knowledge absorption and Diffusion of Innovation

Question	Related factor
PACAP	
19. During the technological trajectory of the enterprise, how did you organize yourself to obtain knowledge to innovate?	organizational capacity
20. Explain how the relationship with external actors was, including customers, occurred to identify and acquire external knowledge to innovate.	openness to innovation
21. Explain how partnerships and external support for the development of innovations occurred.	Social capital, networks, partnerships and cognitive ability
22. By what other means did you obtain knowledge for the development of innovation?	Means of acquiring knowledge
23. How did you manage the knowledge you absorbed to innovate?	Ability to acquire, develop and manage knowledge
24. How did you develop skills to learn about external knowledge or technologies?	learning capacity
25. Describe how you used human, physical and financial resources in the development of innovation.	Ability to use organizational resources
RACAP	
26. How do you evaluate the previous experience that the team had, including academic and professional experience?	Human capital for innovation
27. How were partners used for innovation research and development?	RD&I capacity
28. What is your perception of your company's technological capabilities to innovate (physical, knowledge, human capital)?	technological capacity
29. Were additional external capabilities required?	technological capacity
30. Evaluate strategies that the company has adopted to protect the knowledge and technology developed.	Protection of knowledge, technology, innovation and appropriability
31. How was the introduction and diffusion of the innovation in your market?	Capacity to generate innovation results through market introduction channels
32. What were the facilitating and supporting factors for introducing the innovation to the market?	Capacity to generate innovation results through new technologies and financial investments
33. What were the main difficulties in introducing the innovation to the market?	Ability to generate innovation results related to market introduction barriers