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EXPLORING THE RELATIONSHIP BETWEEN DYNAMIC CAPABILITIES AND INNOVATION PERFORMANCE IN TECHNOLOGY-BASED STARTUPS

EXPLORANDO A RELAÇÃO ENTRE CAPACIDADES DINÂMICAS E O DESEMPENHO DE INOVAÇÃO EM *STARTUPS* DE BASE TECNOLÓGICA

EXPLORANDO LA RELACIÓN ENTRE CAPACIDADES DINÁMICAS Y DESEMPEÑO DE INNOVACIÓN EN STARTUPS DE BASADA TECNOLÓGICA

ABSTRACT

Objective: To explore the relationship between dynamic capabilities and innovation performance in technology-based startups.

Methodology: We measured the constructs of Absorptive Capacity, Adaptive Capacity, Innovative Capacity, and Innovation Performance. We collected data from 15 startups and used the Qualitative Comparative Analysis (QCA) methodology for data analysis.

Results: The results showed that dynamic capabilities play a relevant role in the innovation performance of technology-based startups. Different combinations of these capabilities were associated with positive innovation performance.

Theoretical implications: The results of this research contribute to the advancement of theoretical knowledge in the field of study, providing a deeper understanding of the causal relationships and regularities present in the phenomenon investigated.

Social implications: Analyzing dynamic capabilities and their impact on innovation performance is expected to provide insights into developing effective innovation strategies and the sustainable growth of technology-based startups.

Originality: Although studies have explored organizational dynamic capabilities in different contexts, there are still theoretical-empirical gaps in understanding the relationship between dynamic capabilities and innovation performance in technology-based startups. Therefore, this study contributes to the literature by providing a more individualized view of the configurations of dynamic capabilities in technology-based startups and their relationship with innovation performance. We adopted the Qualitative Comparative Analysis (QCA), which combines qualitative and quantitative approaches to examine the analytical coherence of a set of cases regarding the relevant causal conditions.

Limitation and future studies: We need to consider a

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limitation, namely the restricted sample of companies used in the study, which limits the generalization of the results, although the investigation effectively invited several startups to participate in the research. We recommend that future studies advance knowledge in the field of dynamic capabilities in technology-based startups in connection with other variables, such as profitability and growth, business environment, cooperative capacity, volume of innovations, internationalization, and strategic leadership, which are beyond the scope of this study

Keywords: Absorptive capacity. Adaptive capacity. Innovative capacity. FsQCA.

RESUMO

Objetivo: Explorar a relação entre capacidades dinâmicas e o desempenho de inovação em startups de base tecnológica.

Metodologia: Mensuraram-se os construtos de Capacidade Absortiva, Capacidade Adaptativa, Capacidade Inovativa e Desempenho de Inovação. A coleta de dados foi realizada em 15 startups e, para a análise dos dados, utilizou-se a metodologia de Análise Qualitativa Comparativa (QCA).

Resultados: Os resultados apontaram que as capacidades dinâmicas desempenham papel relevante no desempenho de inovação das startups de base tecnológica. Diferentes combinações dessas capacidades se associaram a um desempenho de inovação positivo.

Implicações teóricas: Os resultados desta pesquisa contribuem para o avanço do conhecimento teórico no campo de estudo, fornecendo uma compreensão mais profunda das relações causais e das regularidades presentes no fenômeno investigado.

Implicações sociais: Espera-se que a análise das capacidades dinâmicas e de seu impacto no desempenho de inovação forneça insights ao desenvolvimento de estratégias de inovação eficazes e ao crescimento sustentável de startups de base tecnológica.

Originalidade: Embora estudos tenham explorado as capacidades dinâmicas organizacionais em diferentes contextos, ainda existem lacunas teórico-empíricas, quando se trata da compreensão da relação entre capacidades dinâmicas e o desempenho de inovação em startups de base tecnológica. Destarte, este estudo contribui com a literatura ao fornecer uma visão mais individualizada das configurações das capacidades dinâmicas em startups de base tecnológica e a sua relação com o desempenho de inovação. Ademais, utilizou-se a Análise Qualitativa Comparativa (QCA), método que combina abordagens qualitativas e quantitativas para examinar a coerência analítica de um conjunto de casos em relação às condições causais relevantes.

Limitação e estudos futuros: Uma limitação precisa ser considerada, a saber, a amostra restrita de empresas utilizada no estudo, o que limita a generalização dos resultados, embora a investigação tenha efetivamente convidado um número alto de startups para participarem do estudo. Recomenda-se a realização de estudos futuros para avanço do conhecimento no campo das capacidades dinâmicas em startups de base tecnológica em conexão com outras variáveis, como lucratividade e crescimento, ambiente de negócios, capacidade cooperativa, volume de inovações, internacionalização e liderança estratégica, que fogem do escopo deste estudo.

Palavras-chave: Capacidade absortiva. Capacidade adaptativa. Capacidade inovativa. FsQCA.

RESUMÉN

Objetivo: Explorar la relación entre las capacidades dinámicas y el desempeño de la innovación en startups de base tecnológica.

Metodología: Se midieron los constructos de Capacidad de Absorción, Capacidad de Adaptación, Capacidad de Innovación y Desempeño de Innovación. La recolección de datos se realizó en 15 startups y, para el análisis de los datos, se utilizó la metodología de Análisis Comparativo Cualitativo (QCA).

Resultados: Los resultados mostraron que las capacidades dinámicas juegan un papel relevante en el desempeño de innovación de las startups de base tecnológica. Diferentes combinaciones de estas capacidades se asociaron con un

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desempeño positivo en innovación.

Implicaciones teóricas: Los resultados de esta investigación contribuyen al avance del conocimiento teórico en el campo de estudio, proporcionando una comprensión más profunda de las relaciones causales y regularidades presentes en el fenómeno investigado.

Implicaciones Sociales: Se espera que el análisis de las capacidades dinámicas y su impacto en el desempeño de la innovación proporcione información sobre el desarrollo de estrategias de innovación efectivas y el crecimiento sostenible de las startups de base tecnológica.

Originalidad: Si bien los estudios han explorado las capacidades dinámicas organizacionales en diferentes contextos, todavía existen vacíos teórico-empíricos a la hora de comprender la relación entre las capacidades dinámicas y el desempeño de la innovación en las startups de base tecnológica. Por lo tanto, este estudio contribuye a la literatura al proporcionar una visión más individualizada de las configuraciones de capacidades dinámicas en startups de base tecnológica y su relación con el desempeño de la innovación. Además, se utilizó el Análisis Comparativo Cualitativo (QCA), un método que combina enfoques cualitativos y cuantitativos para examinar la coherencia analítica de un conjunto de casos en relación con las condiciones causales relevantes.

Limitaciones y estudios futuros: Es necesario considerar una limitación, a saber, la muestra restringida de empresas utilizadas en el estudio, lo que limita la generalización de los resultados, aunque la investigación efectivamente invitó a un gran número de startups a participar en el estudio. Se recomienda realizar futuros estudios para avanzar en el conocimiento en el campo de las capacidades dinámicas en las startups de base tecnológica en conexión con otras variables, como rentabilidad y crecimiento, entorno de negocios, capacidad cooperativa, volumen de innovaciones, internacionalización y liderazgo estratégico, que están fuera del alcance de este estudio.

Palabras clave: Capacidad de absorción. Capacidad de adaptación. Capacidad de innovación. FsQCA.

INTRODUCTION

Startups are organizations designed to create innovative products and services under conditions of uncertainty. Unlike traditional organizations, startups require a management approach adapted to uncertain environments, in which it is necessary to learn how to develop a sustainable business, transform ideas into products, measure customer reactions, and make decisions for success (Quaiser & Srivastava, 2024; Polidoro & Jacobs, 2023; Nabarreto, 2020). The Dynamic Capabilities approach, which can be absorptive, adaptive, and innovative, is essential to drive the growth and differentiation of startups in a highly challenging scenario (Castro & Lanzara, 2023; Alvarenga, Costa, & Ruas, 2022; Couto, Teberga, Castro, & Oliva, 2019; Gonçalves, Vargas, & Gonçalves Filho, 2019).

An organization's dynamic capabilities are an increasingly recurring topic in research on business strategy. These capabilities refer to the company's ability to integrate, build, and reconfigure internal and external competencies to face constantly changing environments (Teece, 2007). Studies have highlighted the relevance of dynamic capabilities in organizational performance, in obtaining and sustaining competitive advantage, and in innovation performance (Gonçalves, Vargas, & Gonçalves Filho, 2019; Tsai & Lan, 2006; Wang & Ahmed, 2007).

Innovation performance refers to an organization's ability to generate and implement innovative ideas effectively, resulting in improvements in productivity, competitiveness, and added value (Laursen & Salter, 2006). Innovation performance is measured through indicators such as the number of registered patents, the rate of new products launched, the impact on the market, and the efficiency of innovation processes (Gonçalves, Vargas, & Gonçalves Filho, 2019; Huizingh, 2011; Subramanian & Nilakanta, 1996).

Business incubators are organizations that support the establishment and growth of new companies, which can be technology-based or traditional, providing tangible resources such as physical space, equipment, and administrative services, as well as intangible resources such as knowledge and access to their social capital and relationship networks, which allows companies

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to mitigate the initial vulnerability of companies. Therefore, incubators are strategic means to yield innovation (Paula, Santos, & Couto, 2023; Grilli & Marzano, 2023; Hausberg & Korreck, 2020).

In the context of technology-based startups, innovation performance plays an even more relevant role. These companies constantly seek to develop and launch new disruptive technologies, products, or services that meet market needs. They depend on their ability to identify opportunities, transform ideas into solutions, and implement them successfully to remain competitive and drive their growth (Catela, 2022; Chesbrough, 2003; Dodgson, Gann, & Salter, 2008). Technology-based companies (TBCs) present higher technological risks. That differentiates them from traditional companies. Depending on the sector in which they operate, TBCs require a greater contribution of financial capital from their entrepreneurs (Paula, Santos, & Couto, 2023; Tumelero, Sbragia, Borini, & Franco, 2018; Tumelero, Santos, & Kuniyoshi, 2016).

Therefore, seeking high innovation performance becomes essential for technology-based companies. They need to develop effective innovation strategies, establish agile development processes, and manage resources to obtain competitive advantage through innovation (Catela, 2022; Jansen, Van Den Bosch, & Volberda, 2006; Lichtenthaler, 2008). Innovation plays a significant role in startups and was defined by Schumpeter (1950), one of the seminal authors on the subject, as the company's ability to generate new products or services that customers want or the adoption of new ideas and internal processes.

As startups operate in uncertain and constantly changing environments, they need to be able to identify opportunities, adapt quickly, and reconfigure their resources and competencies according to market demands (Catela, 2022; Eisenhardt & Martin, 2000). However, dynamic capabilities and the search for innovation can be challenging for startups, which need to configure their resources and capabilities to withstand the pressure for quick results and the need to balance exploring new opportunities with utilizing existing capabilities (Quaiser & Srivastava, 2024; Eisenhardt & Martin, 2000; Zahra & George, 2002). This article uses the expression dynamic capabilities to represent absorptive, adaptive, and innovative capabilities.

The ability to develop processes of absorption and reevaluation of knowledge is known as Absorptive Capacity (Castro & Lanzara, 2023; Alvarenga, Costa, & Ruas, 2022; Cohen & Levinthal, 1990). In startups, absorptive capacity plays a relevant role since these companies operate in environments of rapid change and uncertainty, where innovation, aligned with customer demands and specifications, is essential for their survival and growth.

Adaptive capacity, in turn, is a capital skill for organizations to deal with the dynamics of changes in the external environment. Through adaptive capacity, it is possible to develop a competitive advantage, allowing the company to adapt and, as a result, improve its performance (Castro & Lanzara, 2023; Alvarenga, Costa, & Ruas, 2022; Kaur, 2023; Wang & Ahmed, 2007).

At last, innovative capacity refers to the organization's ability to develop innovations, such as creating new products, conquering new markets, or implementing improved forms of team integration. Companies achieve this capacity through the alignment between strategic orientation and organizational processes (Castro & Lanzara, 2023; Alvarenga, Costa, & Ruas, 2022; Kaur, 2023; Kim, 1997; Wang & Ahmed, 2007).

Studies have explored organizational dynamic capabilities in different contexts. Hattore (2021), for instance, investigated the hotel sector to identify which dynamic capabilities determine long-term stay in the market. Fernandes (2021), in turn, approached the e-commerce retail sector to identify which dynamic capabilities contribute to high financial resilience. At last, Bispo, Gimenez, and Kato (2016) investigated industrial organizations concentrated sectorally and geographically to describe the relationship that the environment, strategy, dynamic capabilities, and coopetition establish with performance.

However, there are theoretical-empirical gaps with respect to understanding the relationship between dynamic capabilities and innovation performance in technology-based startups (Gonçalves, Vargas, & Gonçalves Filho, 2019). Therefore, this study aims to contribute to the literature by providing a more individualized view

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of the configurations of dynamic capabilities in startups and their relationship with innovation performance. In this scenario, the research sought to answer the following question: which configurations between absorptive, adaptive, and innovative capabilities are consistent with high innovation performance in startups? Therefore, the main objective of this study was to explore the configurations between absorptive, adaptive, and innovative capabilities consistent with high innovation performance in startups. Thus, we expect that analyzing dynamic capabilities and their impact on innovation performance will provide insights into developing effective innovation strategies and the sustainable growth of technology-based startups, making it possible to contribute to advancing knowledge in this field of study.

To achieve this study's primary objective, we measured the constructs of Absorptive Capacity, Adaptive Capacity, Innovative Capacity, and Innovation Performance. We collected data from 15 startups and used the Qualitative Comparative Analysis (QCA) methodology for data analysis, detailed in the methodological procedures section. The results showed that dynamic capabilities play a relevant role in the innovation performance of technology-based startups. Different combinations of these capabilities were associated with positive innovation performance.

This study comprises five sections. In addition to this introductory section, in which we presented the problem, objectives, and justification, the subsequent section presents the theoretical framework taken as the background of the investigation. Afterward, we present the methodological procedures adopted in the study, followed by the results discussed in light of theory and previous studies related to the topic. The last section makes final considerations, presenting the study's limitations and suggesting further research.

THEORETICAL FRAMEWORK

Startups play a significant role in the business scenario, driving innovation and contributing to economic development. These companies are characterized by the intensive use of technology in their products, services, and processes, their innovative nature, and focus on creating and commercializing advanced technologies (Organization for Economic Co-operation and Development [OECD], 2010). These companies are often involved in research and development (R&D) activities, seeking new technological solutions and improving existing products (Quaiser & Srivastava, 2024; Polidoro & Jacobs, 2023; Arora, Athreye, & Huang, 2016). The emphasis on technological innovation is one of the primary characteristics that differentiate startups from other types of companies (Nabarreto, 2020; Arora, Athreye, & Huang, 2016; OECD, 2010).

The ability to develop and commercialize disruptive technologies and create innovative business models, characteristic of startups, is fundamental to gaining a competitive advantage (Chesbrough, 2003). Technological innovation is not limited to producing new products but also involves the creative application of technology to existing processes and services (OECD, 2010). For instance, Garbuio and Lin (2019) developed a study that showed that startups that use artificial intelligence may drastically change the healthcare field, as they propose solutions that change how to prevent, diagnose, and even cure diseases.

Technological product innovation comprises new technological products and their improvement. The first form happens when the product has characteristics and uses that differ considerably from those previously produced. This innovation is the basis for a new disruptive technology, a combination of existing technologies with a new application, or may be a derivation of the use of new knowledge. The second form manifests itself when an existing product undergoes a significant improvement process, either by increasing its performance or reducing its costs (OECD, 2010).

Studies have explored the topic of innovation and startups and their interfaces with other knowledge fields. For instance, Brazil (2022) developed an investigation that intertwined the

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themes of innovation, Law, and entrepreneurship in startups, seeking to understand which aspects of innovation need to be adapted to Law to practice entrepreneurship with legal security. The author concluded that there is a need for greater regulation of Law and higher interaction between it and new technologies to provide principles capable of protecting the dynamics of digital entrepreneurship.

In turn, Marcon and Ribeiro (2021) analyzed how startups structure, group, and leverage the resources of actors in the innovation ecosystem throughout the creation, development, and market phases. The authors concluded that, during the creation phase, interaction with non-market-oriented actors predominates, with startups focusing on adding innovation and social resources. In the development phase, interactions involve a balanced integration of market-oriented and non-market-oriented actors, with startups focusing on adding innovative, social, and organizational resources. Finally, in the market phase, interactions with market-oriented actors predominate, with startups continuing to add innovation and social resources, although of a different nature. These findings highlight changes in the needs of startups throughout their life cycle.

Wright, Koning, and Khanna (2023) suggest that when incubator directors evaluate promising startup ideas, they do not do so impartially. The authors empirically demonstrated that incubator directors tend to support startup ideas from their own country. In turn, Cantamessa, Gatteschi, Perboli, and Rosano (2019) draw attention to the fact that the literature tends to highlight successful cases of technology-based startups. According to the authors, technology-based startups have a high failure rate due to their high risk, and such failures need to be discussed, as they can represent learning. Furthermore, the authors highlighted the need to investigate innovation performance and its antecedents, which the present research proposes to do.

Innovation performance is an aspect that cannot be overlooked for the success of a company or country, reflecting the ability to engage in innovative activities and generate effective results. This measure encompasses a series of factors and indicators that reflect the effectiveness and success of innovation efforts. Benchmarking manifested in the search for good competitors' practices is highlighted as a relevant measure to develop unique products and continuously improve innovative capacity (Bate, Wachira, & Danka, 2023).

According to Xu (2023), innovation performance refers to the effectiveness and success of innovative activities within a given context. It encompasses the ability of organizations or countries to generate, implement, and benefit from innovative ideas, processes, products, or services. It is possible to measure innovation performance through several indicators, such as the number of registered patents, investments in research and development (R&D), new product launches, market share gains, and improvements in productivity or efficiency (Gonçalves, Vargas, & Gonçalves Filho, 2019; Huizingh, 2011; Subramanian & Nilakanta, 1996).

Innovation plays a fundamental role in startups and consists of the ability of these companies to create and introduce new products, services, processes, or business models into the market that meet the needs and desires of customers (Schumpeter, 1950; Utterback & Afuah, 1998). In a highly competitive and constantly evolving business environment, the search for innovation is relevant for the growth and development of startups. Considering that startups operate in highly uncertain environments, it is beneficial to identify emerging opportunities, adapt quickly to changes, and reconfigure their resources and competencies according to market demands with absorptive, adaptive, and innovative capabilities (Teece, 2007).

Employees' experience enhances absorptive capacity as employees bring prior knowledge to make decisions and promote improvements in internal and external relationships (Cruz & Corrêa, 2018; Cohen & Levinthal, 1990). It is essential that startups acquire, assimilate, transform, and explore external knowledge, thus taking advantage of their absorptive capacity to develop their full potential. Extracting knowledge from external sources enhances the attributes of startups, increasing their speed of adaptation and the acceptance of their products in the market.

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Transforming ideas into products is shaped by the sources of knowledge absorbed, assimilated, transformed, and explored to develop competitive advantage (Debrulle, Maes, & Sels, 2014). The association of abilities to capture, absorb, and employ external knowledge is fundamental to maximizing the innovation process. External knowledge is integrated into the organization's knowledge base, promoting the development of resilience in a highly dynamic environment (Kaur & Mehta, 2016; Monferrer, Blesa, & Ripolles, 2015).

Studies on absorptive capacity divide it into two distinct but complementary groups: potential absorptive capacity and realized absorptive capacity (Zahra & George, 2002). Potential absorptive capacity deals with how companies seek external knowledge and the tools they use to acquire, incorporate, and assimilate it. Realized absorptive capacity deals with how the organization modifies and concentrates external information to incorporate it, in addition to the mechanisms for transforming and applying this knowledge (Cruz & Corrêa, 2018). According to Zahra and George (2002), absorptive capacity comprises four dimensions: acquisition, assimilation, transformation, and application of knowledge. The development and application of these dimensions are fundamental to building competitive advantage.

Organizations with adaptive capacity can carry out the following essential actions: quickly identify changes occurring in the environment, analyze these changes to recognize possible market trends, and allocate resources according to the analyses carried out. Resource flexibility is essential to respond appropriately to unpredictable transformations, allowing the organization to adapt to the new context, aligning with its strategic priorities (Akgun, Keskin, & Byrne, 2012; Wang & Ahmed, 2007).

Adaptive capacity directly influences innovation, enabling the company to restructure its operations and develop continuous improvements in the face of environmental changes. Innovation plays a fundamental role in the renewal of startups, allowing the restructuring of their products or services and adaptation to the market, offering new value to customers, whether incrementally or revolutionary (Ries, 2011). Furthermore, adaptive capacity also plays a relevant role in effectively managing the company's resources. By monitoring and analyzing changes in the external environment, the organization can reallocate its resources strategically, directing them to areas and projects with higher potential for success and offering competitive advantages (Eisenhardt & Martin, 2000).

At last, organizations with innovative capacity can incorporate their skills and assets efficiently to drive innovation (Donkor et al., 2018). That allows the organization to continually transform knowledge into new innovative products, processes, and behaviors (Kaur, 2023; Tsai & Lan, 2006). This ability leads startups to conceive, develop, and implement new configurations of products, services, and improved processes and to transform and optimize the technology in use. This concept encompasses both the exploration of new revolutionary ideas and the exploitation and improvement of existing ideas (Bell, 2012).

In the dynamic and competitive context where organizations, especially startups, are inserted, innovative capacity is relevant for survival and growth (Tidd & Bessant, 2005). This capacity involves the ability to develop new and creative solutions (Damanpour, 2014), explore market opportunities (Atuahene-Gima & Ko, 2001), absorb external knowledge (Cohen & Levinthal, 1990), establish strategic partnerships (Jansen, Van Den Bosch, & Volberda, 2006), and create an organizational culture that promotes innovation (Damanpour & Schneider, 2006).

Considering the need for startups to achieve high innovation performance and the characteristics of absorptive, adaptive, and innovative dynamic capabilities, this article proposes that startups can configure their capabilities in different ways to achieve high innovation performance. Therefore, we suggest the theoretical-empirical model illustrated in Figure 1.

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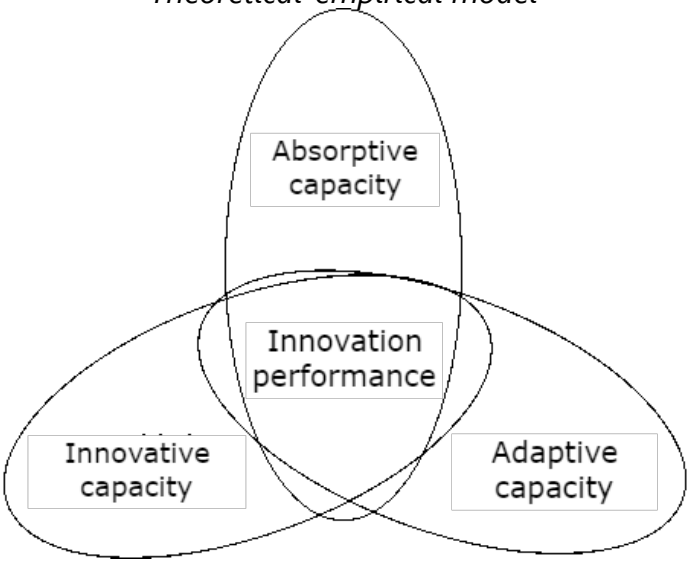
Figure 1

Theoretical-empirical model



This model suggests that organizations can achieve high innovation performance by different configurations based on the three types of dynamic capabilities: absorptive capacity, adaptive capacity, and innovative capacity. After presenting the research theoretical framework, we will explain below the methodological procedures adopted in the study.

METHODOLOGICAL PROCEDURES

The present research explores the possible impact of dynamic capabilities on startups' innovation performance. According to Babbie (2020), the primary purpose of explanatory research is to identify the cause-and-effect relationships between variables, aiming to deepen the understanding of the phenomena investigated. This is a multiple case study (Yin, 2018), allowing an in-depth analysis of the causal relationships involved (Eisenhardt & Martin, 2000).

The constructs used in this study were absorptive capacity, adaptive capacity, innovative capacity, and innovation performance. We used a questionnaire with 37 questions on a 5-point Likert scale to measure these constructs and seven sociodemographic questions. We constructed the questionnaire by selecting questions already validated in the literature.

We used the article written by Cassol, Marietto, and Martins (2022) as a reference for questions related to the absorptive capacity construct. This study examined the elements that comprise the absorptive capacity dimension in small and medium-sized enterprises (SMEs), providing an in-depth understanding of the construct.

We used the article by Biedenbach and Müller (2012) as a reference for questions related to the constructs adaptive capacity and innovative capacity. This research explored how absorptive, adaptive, and innovative capabilities affect the performance of Research and Development projects and portfolios in pharmaceutical and biotechnology organizations. The results of the study provided relevant insights into the impact of these capabilities on performance.

The article by Yuniartya, Prabowoa, and Abdinagoroa (2021), in turn, was used as a reference for questions related to the innovation performance construct. This research analyzed the relationship between the managerial-operational capacity of digital business strategy and innovation performance in small and medium-sized companies (SMEs).

We created the data collection instrument on the Microsoft Forms® platform and sent it to participants by telephone, using the numbers available on the companies' websites and their respective LinkedIn pages. We collected data from September 2022 to May 2023. Initially, we attempted to contact 62 startups, making it possible to speak to 26 managers. Two refused to participate, and 24 were willing to answer the questionnaire. However, only 15 managers sent their responses. Of the remaining 36 companies, in 14 cases, we could not establish contact, while in 22 cases, it was possible to speak to the receptionist or another employee. Of these 22 cases, seven requested the survey to be sent to the responsible employee, and the other 15 were reluctant to provide the person responsible's contact information, noting the demand and contact details for later return.

The 15 startups that constituted the final sample of the study are part of incubators in Minas Gerais state, such as the Parque Tecnológico de Belo Horizonte-MG (BH-TEC incubator), the Parque Tecnológico de Viçosa-MG (CENTER incubator), and the Incubadora de Empresas

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de Base Tecnológica da UNIFIL in Alfenas-MG (NIDUSTEC). The sampled startups mainly operate in the e-commerce and agricultural technology sector and are in the scale and operation phase.

We adopted Qualitative Comparative Analysis (QCA) using the R software to analyze the data in this study. QCA is a method that combines qualitative and quantitative approaches to examine the analytical coherence of a set of cases concerning relevant causal conditions (Rihoux & Ragin, 2008). In this research, we used the fuzzy set QCA (fsQCA) technique, which allows a more precise analysis of the conditions by assigning continuous values from 0 to 1 to the study constructs. fsQCA stands out for its ability to handle information at different levels and provide a more refined measure of the association between conditions and cases. By incorporating the concept of equifinality, diverse combinations of factors can lead to the same result (Park, Pavlou, & Saraf, 2020).

In the fsQCA technique, it is possible to identify the necessary and sufficient conditions to achieve a specific result through consistency and coverage indicators. Consistency assesses the degree to which a result is a subset of a condition, while coverage indicates the relevance of a condition to explain the result (Invernizzi et al., 2020). Data analysis using the QCA approach, particularly fsQCA, allowed a deeper understanding of the causal relationships and logical configurations of the conditions that influence the results (Park, Pavlou, & Saraf, 2020).

We analyzed descriptive statistics for absorptive capacity (ABC), innovative capacity (INC), adaptive capacity (ADC), and innovation performance (INP) to understand the behavior of the study constructs and establish the calibration parameters of the FsQCA technique. We used the 10th percentile, median, and 90th percentile to calibrate the analysis model, grouped the average values of each construct in an electronic spreadsheet, and subsequently imported them into the R software. We established the 10th percentile as the point of full non-adherence (fuzzy value equal to 0), the median as the crossing point (fuzzy value equal to 0.5), and the 90th percentile as the point of full adherence (fuzzy value equal to 1). After the calibration process, the R software generated the corresponding fuzzy values.

To carry out the FsQCA analyses, we proceeded according to the following script: 1) to build a table with the fuzzy data; 2) to build a truth table; 3) to perform Boolean minimization; 4) to present the results of parsimonious, intermediate, and complex solutions; and 5th) to interpret the results. The construction of the truth table was limited to configurations with a minimum of two cases, and the results were considered positive (survival) for consistency scores (incl) greater than 0.9. Next, we verified the necessity analysis. This analysis sought to answer whether the presence or absence of a condition, separately, could be considered necessary to lead to the result, in this case, high innovation performance or its absence. To this end, we calculated consistency and coverage indicators.

For the condition or its absence separately to be considered necessary to lead to the result (or its absence), its consistency has to be greater than 0.9. Finally, we created a truth table to visualize the possible combinations between the different conditions. Subsequently, Boolean minimization was applied, which is a process to simplify the truth table and identify the most relevant patterns. We presented the results in three different solutions: parsimonious, intermediate, and complex, each showing diverse configurations of the conditions.

RESULTS AND DISCUSSION

We first analyze the characteristics of the startups considered in the study. Concerning the sector of activity, most companies investigated (40%) are part of the electronic commerce (E-commerce) sector. Next, agricultural technology companies (Agtechs), with 26.7%, and a proportion of 6.7% for companies in the sanitation, consultancy, and food technology (Foodtechs) fields. Only two startups did not inform their sector of activity.

Concerning the target audience of startups, 46.7% focus on trade between legal entities (B2B: business-to-business), while 20% focus on trade between legal entities and individuals (B2C: business-to-consumer). Furthermore, 20% target the B2B2C (business-to-business-to-consumer) model and one startup mentioned the B2BB2C

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model. Only one participating startup did not inform its target audience.

Among the startups participating in the study, 46.7% are associated with the Parque Tecnológico de Belo Horizonte-MG (BH-TEC incubator). In comparison, the Parque Tecnológico de Viçosa-MG (CENTEV incubator) and the Incubadora de Empresas de Base Tecnológica da UNIFAL in Alfenas-MG (NIDUSTEC incubator) represented 13.3% each. Other incubators had a lower proportion of 6.7% each, including the Incubadora de Empresas de Base Tecnológica da UFLA in Lavras-MG (INBATEC incubator), the Incubadora do Instituto Nacional de Telecomunicações (INATEL startups), and the Incubadora do Centro Regional de Inovação e Transferência de Tecnologia in Juiz de Fora-MG (CRITT incubator). Only one startup did not inform the incubator or community it is associated with.

Regarding the startup phase, 53.3% are in the scale phase, indicating that they are growing quickly. Furthermore, 40% of startups are in the operation phase, which shows an established and stable business model. Only one startup mentioned being in the traction phase when the company has already gone through the initial stage of development and validation of its business model and is starting to gain momentum and significant growth.

As for the business model, 46.7% of startups focus on direct product sales, followed by 13.3% that offer Licensing and Service Provision. Furthermore, 13.3% have business models based on Consulting and Market Creation (Marketplace). One participating company mentioned adopting the Software as a Service (SaaS) model.

Regarding the number of startup employees, the proportion was relatively even. 26.7% of companies have 6 to 10 employees, and 26.7% have less than five employees. Furthermore, 40% of startups have between 11 and 20 employees, while only one has a team of 21 to 50 workers.

We analyzed descriptive statistics for Absorptive Capacity (ABC), Innovative Capacity (INC), Adaptive Capacity (ADC), and Innovation Performance (INP) to understand the behavior of the study constructs and establish the calibration parameters of the FsQCA technique. Table 1 presents the results of this analysis.

Table 1

Descriptive statistics of the constructs

Code	Construct	Mean	95%CI	SD	Min.	10^{th}P	MED	90^{th}P	Max.
ABC	Absorptive Capacity	4,59	4,44 - 4,75	0,30	3,94	3,98	4,69	4,94	4,94
INC	Innovative Capacity	3,99	3,74 - 4,24	0,49	3,33	3,43	3,83	4,83	4,83
ADC	Adaptive Capacity	4,12	3,99 - 4,25	0,25	3,67	3,67	4,17	4,50	4,50
INP	Innovation Performance	3,89	3,52 - 4,26	0,73	2,67	2,93	3,78	4,89	4,89

Source: Research data.

Note. 95%CI: 95% Confidence Interval; SD: Standard Deviation; Min.: Minimum; 10thP: 10th Percentile; MED: Median; 90thP: 90th Percentile; Max.: Maximum.

The mean results demonstrated high values for the Dynamic Capabilities constructs (Absorptive Capacity, Innovative Capacity, and Adaptive Capacity) and Innovation Performance. It is also possible to note that the variability of companies concerning the analyzed constructs is low, with the highest variability found referring to Innovation Performance. At last, the Minimum value, 10th Percentile, Median, 90th Percentile, and Maximum value provide information about the distribution of scores for each construct. In this case, we used the 10th Percentile, the Median, and the 90th Percentile to calibrate the analysis model.

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Because we used a validated scale, the mean values of each construct were considered for each case, grouping the data in an electronic spreadsheet and importing it into the R software. In fuzzy set association scores, the "calibrate" function of the QCA package, developed by Duşa (2018), was used. The qualitative anchors used in the calibration process, in turn, are detailed in Table 2.

We adopted the approach proposed by Linton and Kask (2017) to define qualitative anchors using a relative scale. We established the 10th percentile as the point of full non-adherence (fuzzy value equal to 0), the median as the crossing point (fuzzy value equal to 0.5), and the 90th percentile as the point of full adherence (fuzzy value equal to 1). After the calibration process, the R software generated the corresponding fuzzy values.

Table 2

Qualitative anchors for calibration

		Calibration rules	
Code	**Construct**	**Scores**	**Fuzzy value**
ABC	Absorptive Capacity	If ABC ≥ 4.938	1
		If ABC = 4.688	0.5
		If ABC ≤ 3.975	0
INC	Innovative Capacity	If INC ≥ 4.833	1
		If INC = 3.833	0.5
		If INC ≤ 3.433	0
ADC	Adaptive Capacity	If ADC ≥ 4.500	1
		If ADC = 4.167	0.5
		If ADC ≤ 3.667	0
INP	Innovation Performance	If INP ≥ 4.889	1
		If INP = 3.778	0.5
		If INP ≤ 2.933	0

Source: Research data.

To carry out the FsQCA analyses, we proceeded according to the following script: 1) to build a table with the fuzzy data; 2) to build a truth table; 3) to perform Boolean minimization; 4) to present the results of parsimonious, intermediate, and complex solutions; and 5th) to interpret the results. The construction of the truth table was limited to configurations with a minimum of two cases, and the results were considered positive (survival) for consistency scores (incl) greater than 0.9.

Next, we verified the necessity analysis. This analysis sought to answer whether the presence or absence of a condition, separately, could be considered necessary to lead to the result, in this case, high innovation performance or its absence. To this end, we calculated consistency and coverage indicators, as shown in Table 3.

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Table 3
Necessity analysis

	Result		Result denial	
Condition	**Consistency**	**Coverage**	**Consistency**	**Coverage**
ABC	0.774	0.758	0.494	0.461
INC	0.761	0.807	0.423	0.427
ADC	0.605	0.63	0.585	0.580
~ ABC	0.449	0.482	0.741	0.758
~ INC	0.460	0.455	0.809	0.763
~ ADC	0.597	0.601	0.627	0.602

Source: Research data.
Note. The symbol ~ represents the absence of the condition.

For the presence of a condition (or its absence) separately to be considered necessary to lead to the result (or its absence), its consistency should be higher than 0.9. This way, separately, we realized no condition (or its absence) was necessary to lead to the result of high Innovation Performance or its absence. Based on these results, we sought to answer which combinations of conditions (or their absence) could consistently lead a startup to obtain high Innovation Performance.

Next, we created a truth table (Table 4) to visualize the possible combinations between the different conditions. Subsequently, Boolean minimization was applied, which is a process to simplify the truth table and identify the most relevant patterns. We presented the results in three solutions: parsimonious, intermediate, and complex, each showing diverse configurations.

Table 4
Truth table

Conf.	ABC	INC	ADC	OUT	n	incl	Cases
7	1	1	0	1	4	0.989	1, 9, 11, 12
8	1	1	1	1	2	0.810	3, 6
1	0	0	0	0	6	0.467	2, 4, 5, 8, 10, 15
4	0	1	1	0	2	0.696	7, 14
2	0	0	1	0	1	0.613	13
3	0	1	0	?	0	-	
5	1	0	0	?	0	-	
6	1	0	1	?	0	-	

Source: Research data.
Note. Conf.: Configuration; ABC: Absorptive Capacity; INC: Innovative Capacity; ADC: Adaptive Capacity; n: number of cases; incl: consistency value.

Two configurations showed results consistent with high Innovation Performance. Configuration 7 has four cases (1, 9, 11, and 12) and indicates the presence of Absorptive Capacity and Innovative Capacity and the absence of Adaptive Capacity. This configuration presents a high consistency value (incl = 0.989), thus demonstrating that it is consistent with high Innovation Performance. Configuration 8, in which there are two cases (3 and 6), is characterized by the presence of all Dynamic Capabilities. This configuration also presents a high consistency value (incl = 0.81), demonstrating that it is consistent with high Innovation Performance. In this sense, we can infer that Adaptive Capacity is indifferent to achieving high Innovation Performance.

Configuration 4, with two cases (7 and 14), presents low consistency (incl = 0.696), which indicates no consistency with high Innovation Performance. In this configuration, Innovative Capacity and Adaptive Capacity are present, while Absorptive Capacity is absent. Configuration 2, with one case (13), also presents

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low consistency (incl = 0.613), which indicates no consistency with high Innovation Performance. In this configuration, only Adaptive Capacity is present. Configuration 1, with six cases (2, 4, 5, 8, 10, and 15), also presents low consistency (incl = 0.467), which indicates no consistency with high Innovation Performance. In this configuration, no Dynamic Capability is present, which shows that such startups do not present any dynamic capabilities in their configuration and cannot consistently achieve high Innovation Performance.

After carrying out the analyses, the crucial minimization step available in the QCA package of the R software began. This process is based on applying Boolean algebra to find a more concise and equivalent expression, maintaining the consistency of the desired results. The parsimonious, intermediate, and conservative solutions, presented in Table 5, use "easy" and "difficult" counterfactuals to optimize the logical expression of the results obtained. This way, a simplified but robust way of representing the configurations that lead to the analyzed outcomes is achieved, contributing to a clearer and more concise understanding of the phenomenon under study.

Table 5

Minimized solutions

Solution	Combination	Coverage	Consistency	Cases
Parsimonious	ABC	0.774	0.758	-
Intermediate	ABC * INC	0.664	0.850	1, 9, 11, 12, 3, 6
Conservative	ABC * INC	0.664	0.850	1, 9, 11, 12, 3, 6

Source: Research data.
Note. ABC: Absorptive Capacity; INC: Innovative Capacity.

The parsimonious solution highlights Absorptive Capacity (ABC) as the essential path to explain Innovation Performance with a consistency of 0.758. The coverage of 0.774 indicates a proportion of belonging to the group of high-performance innovation startups of 77.4%. This solution does not present empirical cases because we used a mathematical method that makes use of all possible combinations, with or without empirical evidence.

The intermediate and conservative solutions presented the same result. In both solutions, the combination between Absorptive Capacity (ABC) and Innovative Capacity (INC) presents a consistency of 0.850. The coverage of 0.664 indicates a proportion of belonging to the group of high-performance innovation startups of 66.4%. However, the unique coverage of 0.850 suggests that this configuration can explain about 85% of the analyzed cases.

In general, the results of this investigation pointed to the relevance of Absorptive Capacity (ABC) as an essential condition in explaining the high Innovation Performance of startups. The intermediate and conservative solutions add the variable Innovative Capacity (INC), forming a configuration consistent with high Innovation Performance. This configuration presented higher empirical evidence. However, the three solutions with Absorptive Capacity (ABC) demonstrate that this capacity is a central condition for obtaining high Innovation Performance. Innovative Capacity (INC) can be considered a peripheral condition. In the context studied, Adaptive Capacity (ADC) proved insignificant in achieving the result of high Innovation Performance.

Considering that startups operate in highly uncertain environments, it is beneficial that they can reconfigure their resources and competencies according to market demands (Teece, 2007). The results of this study highlighted the importance of Absorptive Capacity, which is related to the acquisition, assimilation, transformation, and exploration of external knowledge to develop organizations' potential (Debrulle, Maes, & Sels, 2014). External knowledge is integrated into the organization's knowledge base, promoting the development of resilience in a highly dynamic

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environment (Kaur & Mehta, 2016; Monferrer, Blesa, & Ripolles, 2015). Thus, based on the findings of this research, the absorption and application of external knowledge is relevant to obtaining high Innovation Performance.

To a lesser extent, Innovative Capacity gained prominence, which is related to the effective incorporation of skills and assets to drive innovation (Donkor et al., 2018), allowing the organization to continuously transform knowledge into new products, processes, and behaviors (Kaur, 2023; Tsai & Lan, 2006). Innovative Capacity involves both the exploration of new revolutionary ideas and the exploitation and improvement of existing ideas (Bell, 2012). Therefore, according to the findings of this study, Innovative Capacity would be a reasonable complement to Absorptive Capacity in the search for high Innovation Performance.

It is necessary to highlight that this study does not claim that Absorptive Capacity and Innovative Capacity are the main or only predictors of Innovation Performance. However, it sheds light on capabilities we should consider in explanatory models of high Innovation Performance. As we saw, among the three types of dynamic capabilities, Absorptive Capacity stood out, followed by Innovative Capacity, just as Adaptive Capacity was indifferent. At this point, it is necessary to highlight that such results cannot be generalized to all technology-based startups, especially considering the analysis of only 15 startups in this research. We suggest that the findings of this study be compared and discussed with the empirical results of other investigations on the subject, allowing greater generalization and advancement of knowledge about the factors that have a statistically significant impact on Innovation Performance.

FINAL CONSIDERATIONS

The present investigation points out that startups that can absorb knowledge and generate an environment of innovation, even when not adaptive enough, tend to present a positive innovation performance. This finding suggests that companies with good potential to raise and implement new ideas may face difficulties adapting to environmental changes.

This study also shows that startups with all dynamic capabilities (absorptive, adaptive, and innovative) tend to present positive innovation performance. In this case, companies that can better adapt, generate, and implement innovations consistently tend to achieve high innovation performance.

At last, the present investigation points out that startups characterized by the absence of all dynamic capabilities tend to present lower innovation performance. That suggests that a lack of these skills and resources may limit the ability of companies to generate and implement innovations effectively.

Therefore, dynamic capabilities, such as Absorptive Capacity, Innovative Capacity, and not necessarily Adaptive Capacity, yield an environment conducive to Innovation Performance in technology-based startups. These capabilities allow companies to identify opportunities, adjust to market changes, acquire and apply external knowledge, and generate and implement innovative ideas. The right combination of these capabilities can boost startups' innovation performance, making them more competitive and succeeding in a highly dynamic and challenging business environment.

With these findings, this research contributes to advancing knowledge, highlighting that dynamic capabilities are relevant factors in creating a high-performance innovation environment in technology-based startups. Therefore, we can infer that, by investing in the development of these capabilities, startups have a greater chance of standing out in the market, overcoming challenges, and achieving significant results in terms of innovation.

However, empirical data showed that Adaptive Capacity was not essential for generating innovation performance in the companies analyzed, corroborating the literature that such capacity is highly responsive and not proactive like the others (Gonçalves, Vargas, & Gonçalves Filho, 2019). That may indicate that companies operating in a market sector that is not so dynamic and marked by constant changes may not see the need to adapt because there is no need.

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Although this study has contributed to the understanding of dynamic capabilities and their impact on innovation performance in technology-based startups, we should consider a limitation, namely the restricted sample of companies used in the study, which limits the generalization of the results even though the investigation invited a high number of startups to participate in the study. Most sampled startups are associated with incubators in Minas Gerais state for researchers' accessibility reasons. Therefore, we recommend that further studies focus on other regions of Brazil, whose results we can compare with the findings of the present investigation.

Concerning the universality of the research findings, it is worth mentioning that this study only considers technology-based startups as the research universe. Furthermore, the configurations found in this investigation were affected by the calibration strategy adopted by the authors. Although the findings and analysis of the results found robustness in the data, the research does not have a deductive and universalizing character per se. Other variables like profitability and growth, business environment, cooperative capacity, volume of innovations, internationalization, and strategic leadership, which are beyond the scope of this study, can be complementary to the approach adopted.

Furthermore, we recommend that future studies advance knowledge on dynamic capabilities in technology-based startups by adopting mixed approaches, combining quantitative and qualitative methods, which can provide an even more complete depth of these relationships.

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