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ARTICLE

Knowledge and organizational innovation-based dynamic capabilities in organic agriculture production units

Capacidades dinâmicas baseadas em conhecimento e inovação organizacional em unidades de produção de agricultura orgânica

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Abstract: This study aims to investigate the relationship between the dimensions of knowledge-based dynamic capabilities in innovation performance, operationalized by organizational innovation measures, in organic food production units. The research was carried out using a seven-point Likert questionnaire that measures the relationship between dynamic knowledge-based capabilities (Zheng et al., 2011) and organizational innovation (Camisón & Villar-López, 2010) in a sample of 154 organic food production units collected at ecological fairs in the metropolitan region of Porto Alegre, state of Rio Grande do Sul, Brazil. For data analysis, structural equation modeling was used. The results indicated that knowledge acquisition, generation and combination skills are important positive determinants for organizational innovation. The approach is groundbreaking in the literature as it addresses and broadens knowledge about the process of building knowledge resources and organizational innovation and adds an analysis model for studies in the interdisciplinary field of dynamic capabilities based on resource knowledge and organizational innovations. It contributes to the theory by reporting on empirical quantitative data through a measurement scale adapted and validated based on the proposal of Zheng et al. (2011).

Keywords: dynamic capabilities, organizational innovation organic agriculture, Brazil.

Resumo: O presente estudo tem por objetivo investigar a relação das dimensões das capacidades dinâmicas baseadas em conhecimento no desempenho de inovação, operacionalizado pela medida inovação organizacional, em unidades de produção de alimentos orgânicos. A pesquisa foi desenvolvida por meio de um levantamento em que foi aplicado um questionário do tipo *Likert* de sete pontos que mede a relação entre as capacidades dinâmicas baseadas em conhecimento (Zheng et al., 2011) e inovação organizacional (Camisón & Villar-López, 2010) em uma amostra de 154 unidades de produção de alimentos orgânicos coletados em feiras ecológicas na região metropolitana de Porto Alegre, estado do Rio Grande do Sul, Brasil. Para análise dos dados foi utilizada a modelagem de equações estruturais. Os resultados demonstraram que as capacidades de aquisição, geração e combinação de conhecimento são importantes determinantes positivos para a inovação organizacional. Os resultados demonstraram que as capacidades de aquisição, geração e combinação de conhecimento são importantes determinantes positivos para a inovação organizacional. A abordagem é inovadora na literatura por abordar e ampliar o conhecimento sobre o processo de construção do recurso conhecimento e inovação organizacional além de acrescentar um modelo de análise para os estudos no campo interdisciplinar das capacidades dinâmicas baseadas no recurso conhecimento e inovações organizacionais. Contribui para a teoria ao relatar uma pesquisa empírica de dados quantitativos por meio de uma escala de mensuração adaptada e validada a partir da proposta de Zheng et al. (2011).

Palavras-chave: capacidades dinâmicas, inovação organizacional, agricultura orgânica, Brasil.

1. Introduction

Organic agriculture has grown significantly with global food and beverage sales totaling €$ 120 billion in 2020. In that same year, it is mentioned that there are 2.97 million hectares of organic agricultural land around the world. Brazil has the largest organic products market in Latin America, with 1.3 million hectares of organic agricultural land in 2020. Available data from 2016 shows that Brazil was responsible for €$126.5 million in exports (Willer et al., 2022). The growth of this market is highlighted on the one hand by the emergence of eco markets along with the retail trade in organic products (Scialabba, 2005). On the other hand, it presents a heterogeneous profile of its consumers who increasingly demand these products (Dias et al., 2016).

With the organic food market prospects for growth, it is vitally important to link consumer needs with the ability of companies to offer these products and exploit these opportunities. Not only explore but develop dynamic capabilities to create, expand, and modify how they compete. Helfat et al. (2007) mention that in changing contexts, companies must explore and adapt to changes in their business environment while seeking opportunities through innovation.

In this study, dynamic knowledge-based capabilities are understood as organizational and strategic processes by which organic food production units manipulate resources that shape, hold, and renew them to generate new organizational assets. Therefore, innovation is approached as a knowledge process that transforms knowledge into new products and services (Wilson, 2007).

The perspective of privileged innovation is the approach of organizational innovation adopted by the field of study of Administration (Gopalakrishnan, 2000). Damanpour (1991) calls it administrative innovation because it is related to the organizational structure and administrative processes, indirectly related to the basic work activities of an organization, and more directly related to innovation management.

In the field of study of the determinants of innovation, there is a broad discussion that encompasses several perspectives, ranging from the evaluation of the influence of internal (formal or informal company) or external (micro or macro) organizational factors, in different contexts (Jantz, 2012; Panizzon et al., 2013). However, the analysis of innovation has long been restricted to technology, especially products and processes, while less research has been focused on organizational innovation (Fontan et al., 2004; Chuang et al., 2014). This fact is clear in the survey of publications on the subject by Birkinshaw & Mol (2006) who found more than 12,700 articles related to technological innovation against only 114 articles on managerial innovation.

Although the dynamic capabilities perspective has become an influential framework for understanding companies' competitive advantages, few empirical studies have been noted (Zheng et al., 2011). In this sense, this study is empirical, and its context of analysis is the organic agriculture in Southern Brazil. In this sector, Mazzoleni & Oliveira (2010) identified characteristics that resemble the dynamic capabilities of Zollo & Winter (2002) when studying the technological capabilities of the vegetable processing agribusiness of an organic production enterprise in the Brazilian Midwest. Burton et al. (1998) investigated potential determinants of producers' decisions to adopt or not adopt organic/biodynamic technologies. Cislaghi et al. (2019) analyzed how competitive and cooperative incentives originating from the buying company influence the economic outcomes of its suppliers. Melo & van Bellen (2022) demonstrated how family-based organic cotton production involves relationships oriented regarding economic, social, and environmental objectives. Brito et al. (2023) described the profile of organic producers, analyzing spatial distribution, the adopted organic compliance assessment system, and productive

diversity. Oliveira et al. (2024) show that innovation in organic agriculture is based on human agency, as collective actions were cited as modernizing and innovative initiatives in the field.

It is worth noting that organic agriculture in Brazil in 2021 had twenty-five thousand organic production units, the majority of which were family farming, and has grown significantly with domestic market revenues of R$ 6,5 billion, an increase of 12% compared to the previous year (Associação de Promoção dos Orgânicos, 2022).

Given the relative scarcity of studies on this subject in this field, it is valid to carry on research focused on dynamic capabilities and organizational innovation. Striving to advance the debate, this study seeks to answer the following research question: 'How do the dimensions of dynamic knowledge-based capabilities relate to the dimensions of organizational innovation?'. Lee & Kelley (2008) point out that dynamic capabilities are a necessary element of the innovation process and point out that only managerial innovation can create long-term benefits (Hamel, 2007).

This study contributes to the literature in several aspects. Firstly, because there is little research trying to understand the applicability of organizational capacity theories in micro companies (Inan & Bititci, 2015). Secondly, due to the focus on organizational innovation. Many studies focus their analysis only on technological innovation, especially on products and processes (Fontan et al., 2004; Freeman & Soete, 2008). The term innovation is predominantly linked to research and development and is associated with the creation of new products (Armbruster et al., 2008). It contributes to the literature since it empirically tests the models by Zheng et al. (2011) and Camisón & Villar-López (2010) seeking a more consistent theoretical development around this theme. Finally, the empirical research presented here, based on a sample of 154 units, validates the role of dynamic knowledge-based capabilities in organizational innovation in organic farming food production units.

The paper is structured as follows. Section 2 contains a literature review and presents the theoretical foundations of the proposed hypotheses. The data and statistical methods used to test the hypotheses are described in Section 3. The results of structural equation modeling are presented and discussed in section 4. The closing section summarizes and concludes the article.

2. Theoretical Foundation

2.1 Dynamic Capabilities

Dynamic capabilities are defined by Teece et al. (1997, p. 516) as "the ability to integrate, build and reconfigure internal and external competencies to cope with rapidly changing environments". The term 'dynamic' is related to changes that occur in the environment of organizations (e.g. technologies, market forces, among others), while 'capacity' refers to the role of strategic management in dealing with changing environmental conditions by adapting, integrating, and reconfiguring internal and external skills, resources and organizational skills to be consistent with your ever-changing business environment (Teece et al., 1997).

The concept seeks to explain the firm's adaptive capacity, through changes in its set of resources and current capacities, to deal with environmental changes and sustain competitive advantages. It reflects how an organization can seize opportunities in its business environment through value creation processes that enable it to change and renew its current processes and foster innovation to achieve a better fit with its environment (Eisenhardt & Martin, 2000; Zollo & Winter, 2002; Helfat et al., 2007).

To develop new capabilities required by the environment, three dimensions (positions, paths, and processes) enable the organization to adapt, integrate, and reconfigure its capacities and

capabilities. According to Teece et al. (1997), organizational processes (routines or patterns of current practice and learning) are shaped by the firm's position (assets, governance structure, consumer base, external relations with suppliers and partners) and pathways (decision history) as well as technological and market opportunities, which determine the "essence of the firm's dynamic capacity and competitive advantage, that is, determine its competence" (Teece et al., 1997, p. 518).

Since the seminal article by Teece et al. (1997), several studies have been published in varied sources with different theoretical-analytical perspectives to develop the concept of dynamic capabilities (Meirelles & Camargo, 2014). Eisenhardt & Martin (2000) advanced the understanding of dynamic capabilities, debunking the criticism of being tautological. They differ from Teece et al. (1997) proposing that competitive advantage comes from existing and new resource configurations that alter the organizational resource base rather than capabilities. For Eisenhardt & Martin (2000) dynamic capabilities are a set of specific and identifiable processes (homogeneity of capabilities) that use resources to match or even create market changes.

It is not only in highly dynamic environments that dynamic capabilities manifest themselves, but some companies also integrate, build, and reconfigure their skills in low-dynamic environments with low rates of change (Zollo & Winter, 2002; Meirelles & Camargo, 2014). Eisenhardt & Martin (2000) cite that dynamic capabilities can take on different characteristics according to two types of markets: a) in moderately dynamic markets companies depend on existing knowledge, with problem-solving processes and activities focusing on organizational routines; b) in high-speed markets focuses on the rapid creation of new situation-specific knowledge.

Zollo & Winter (2002) explore the concept of dynamic capabilities by proposing an alternative definition, based on evolutionary ideas, as "a learned and stable pattern of collective activity through which the organization systematically generates and modifies its operational routines to improve its effectiveness. (Zollo & Winter, 2002, p. 340). In their structure, they use the term 'routines', underlining that dynamic capabilities are structured and persistent, and emerge from learning. For the authors, organizations develop dynamic capabilities through: *i)* accumulation of experience; *ii)* articulation of knowledge; *iii)* knowledge coding processes in the evolution of dynamic and operational routines. Knowledge plays a supporting mechanism for the evolution of routines and is related to dynamic capacity. However, Zollo & Winter (2002) do not offer empirical results to test the proposed model, both from the phenomenon of knowledge evolution, and from the relationship between learning, dynamic capabilities, and routines.

In the Brazilian context, discussions have followed the international literature with theoretical articles such as those by Panizzon et al. (2013), which explore the relationships between internationalization, organizational creativity, and dynamic capabilities based on knowledge as determinants of innovation. Cardoso et al. (2015) map the thematic evolution of the dynamic capabilities field. Panizzon et al. (2013) propose a framework for the analysis of dynamic capabilities based on knowledge and different types of innovation. Guerra et al. (2016) provide a review of the dynamic capabilities theme. Pereira & Macieira (2019) discuss how these dynamic capabilities can be developed with the aid of knowledge management.

The studies presented above form the basis of dynamic capabilities research. Its concept related to the source of competitive advantage has led to much literature in recent years, often in a non-homogeneous and consensual manner (Barreto, 2010), on a fragmented basis (Wang & Ahmed, 2007). These various points of view and approaches have generated an extremely rich body of knowledge, but are often disconnected from research, pointing in different directions (Barreto, 2010), which seek to explain a variety of organizational issues (Zheng et al., 2011), leading to the emergence of a series of criticisms, such as those related to their indeterminism, tautology and inconsistency of certain assumptions (Meirelles & Camargo, 2014; Arend &

Bromiley, 2009). This is because the research is significantly theoretical or case-based, and the operationalization and empirical validation of the construct is still a major challenge (Zheng et al., 2011) for the advancement of the consolidation of the theory (Barreto, 2010).

In Brazil, empirical studies such as that of Souza & Amato Neto (2010) have assessed the entry of small and medium-sized producers into the global market, using the global value chain and dynamic capabilities as a basis. Padilha et al. (2019) investigated dynamic capabilities as a competitive advantage based on the resources and competencies of a dairy factory. Nascimento & Zawislak (2020) discuss how commercialization and cooperation relationships can complement the limited innovation capabilities of agribusiness companies. Leo et al. (2022) researched innovation capabilities for selected Brazilian agribusiness companies across different stages of the value chain. It is evident that the national literature also features various studies seeking to explain various issues within the researched organizations, whether using the dynamic capabilities approach as the main or complementary theory.

The theory of dynamic capacities overlaps with the construct of absorptive capacity (Zheng et al., 2011). The concept of absorptive capacity was originally delineated by Cohen & Levinthal (1990, p. 128), who defined it as "the ability to recognize the value of new external information, assimilate it and apply it to commercial purposes". For the absorption of new information, Cohen & Levinthal (1990) mention that the organization must have prior knowledge to recognize the new information as relevant and thus assimilate and use new knowledge. The assimilation of external knowledge has also been approached by other authors, such as Lane & Lubatkin (1998) who present the concept of relative absorption capacity and Zahra & George (2002, p. 186), who started from the initial definition of absorption capacity, proposed the dimensions *potential absorption capacity* and the *absorption capacity realized*, and defined them as "a set of organizational routines and processes by which the company acquires, assimilates, transforms and exploits knowledge to create value".

The literature analyzed here converges to the knowledge related to dynamic capacities. The premise is that dynamic capabilities must use and renew their tangible and intangible resources, including knowledge, to sustain competitive advantage (Easterby-Smith & Prieto, 2008). Since knowledge is a key intangible resource, the company's primary function is to integrate and use knowledge (Grant, 1996).

Han & Li (2015) mention that in the knowledge age, the concept of dynamic knowledge-based capabilities is introduced, leading to the emergence of several studies such as Nielsen (2006), Wang et al. (2007), Zheng et al. (2011), Denford (2013) and Makkonen et al. (2014) who explore typologies, dimensions, relationships with embedded networks, knowledge management, performance of the concept, among other characteristics. In this study, the construct proposed by Zheng et al. (2011) is explored as it presents empirical and statistically tested results. Having said that, the next topic concerns the approach to dynamic capabilities based on knowledge.

2.2 Knowledge-Based Dynamic Capabilities

The concept of dynamic knowledge-based capabilities proposed by Zheng et al. (2011, p. 1038) is defined as "the company's ability to acquire, generate and combine knowledge resources to detect, explore and direct dynamics of its environment". Zheng et al. (2011) develop the concept from the knowledge-based perspective (KBV) and clarify that knowledge is consistent with the traditional definition, including tacit and explicit knowledge, information and know-how, marketing, technological and managerial knowledge. The authors mention that the construct

is formed by three sub-capacities: knowledge acquisition capacity - CAC; knowledge generation capacity - CGC; and ability to combine knowledge - CCC.

CAC: Knowledge Acquisition Capacity is the company's ability to identify and acquire external knowledge (Zheng et al., 2011) and thus allow knowledge accumulation (Cheng et al., 2016). Scholars also use the concept of absorption capacity (Cohen & Levinthal, 1990) to address this issue, but Zheng et al. (2011) use the concept of knowledge acquisition as the first component of dynamic capabilities.
CGC: Knowledge Generation Capability is an attribute that sets one organization apart from others and is defined as the "ability to develop and refine activities and processes that facilitate the creation/generation of new knowledge" (Zheng et al., 2011, p. 1039). The authors emphasize that the concept encompasses internal R&D, the SECI process proposed by Nonaka (1994), and knowledge creation through external enterprise (Wadhwa & Kotha, 2006).
CCC: The knowledge-combining dimension is "the firm's ability to integrate and apply internal and external knowledge" (Zheng et al., 2011, p. 1039). This ability for this study is important because new knowledge, such as knowledge in the innovation process, is the result of combining new knowledge with existing knowledge or experimenting with new applications for existing knowledge.

The three capabilities do not exist alone but depend on each other. The capacity to acquire knowledge requires a certain amount of base knowledge accumulated and, in addition, influences the process of knowledge creation. In turn, the combination of knowledge refers to the process of gathering and mixing different types of knowledge[1]. (Zheng et al., 2011).

2.3 Organizational Innovation

In the literature, there are several terms for non-technical innovations. One can find nomenclatures such as administrative innovations (Damanpour, 1987), management innovations (Hamel, 2007), and non-technological innovations (Schmidt & Rammer, 2007), among others. Some authors (Armbruster et al., 2008; Evangelista & Vezzani, 2010; Bowen et al., 2010; Camisón & Villar-López, 2011) also underscore that although studies have shown the importance of organizational innovations for business performance, defining, and measuring organizational innovation has not been emphasized in the papers. According to them, there are still few contributions in this regard. Different interpretations of the term 'organizational innovation' and the lack of an accepted definition cause difficulties in the design of studies. In addition, the lack of implementing measures and indicators that support the validity of the term are elements that hamper studies in the area (Armbruster et al., 2008).

Despite the diversity of definitions, there is consensus in the literature on the composition and differentiation between technical (products, processes, and technologies used to produce products or services) and non-technical innovations (related to basic work activity and more directly related to its managerial aspects), such as organizational structure, administrative processes, and human resources.

For Barbieri & Álvares (2002), organizational innovations refer to the introduction of novelties that modify administrative processes, such as decision-making, resource allocation, responsibility assignments, and interpersonal relationships, among others. Armbruster et al. (2008) mention that the lack of implementing measures and indicators hamper studies in the area. For these authors, organizational innovation can be classified as structural and procedural. Structural

[1] The internal structure of this construct is not discussed in this study. For more information see Zheng et al. (2011).

innovation involves changes and improvements in team responsibilities, lines and flows of information, and structure of functions, among others, while the procedural, influences the routines, processes, and operations of a company.

The Organisation for Economic Cooperation and Development OECD (Organização para a Cooperação e Desenvolvimento Econômico, 2005) considers three types of organizational innovations: business practices; the organization of the work environment; and the external relations of the organization. Innovation in business practices is related to new methods of organizing work routines and procedures, which enable the sharing of learning and knowledge within the company. Innovations in workplace organization include new methods for distributing responsibilities and decision-making power among employees in the existing division of labor within the company's activities. Finally, innovations in the external relations of the organization allow new ways to organize the organization's relations with other companies and public institutions (Organização para a Cooperação e Desenvolvimento Econômico, 2005).

2.4 Research Hypotheses

Lee & Kelley (2008), based on the works of Nelson & Winter (1982) and March (1991), propose that the relationship between dynamic capabilities - DC and innovation lies mainly in the following aspects: innovation demands the search for new information beyond existing knowledge; innovation is an uncertain process, providing few predictable and repeatable elements; innovation is similar to 'exploration' as it involves experimentation with new alternatives. Notably, the literature on innovation and business performance discussed that innovation improves company performance (Cho & Pucik, 2005) and requires creation of knowledge in specific situations (Lee & Kelley, 2008; Panizzon et al., 2015). In this context, dynamic capabilities function as a necessary component, as they enable the organization to continually renew its knowledge base and thus cope with changes in its competitive environment (Zheng et al, 2011).

Results of research by Hsu & Sabherwal (2012) show that dynamic capabilities have a positive effect on innovation. Danneels (2010) analyzed how a company's inability to change its resource base prevents it from offering competitive and viable new products. Makkonen et al. (2014) found a statistically significant indirect effect between dynamic capabilities and product innovation performance. In this study, we sought to advance the theoretical development by analyzing the relationships between the dimensions of the dynamic capabilities constructs based on knowledge and organizational innovation, through the measurement scales proposed by Zheng et al. (2011) and Camisón & Villar-López (2010).

In the dynamic capabilities construct in knowledge-based processes, the dimensions of knowledge acquisition and generation are important antecedents of innovation, while the ability to combine knowledge contributes most to innovation activities (Zheng et al., 2011). Considering these arguments, we defined the following research hypotheses:

H1a. Knowledge Acquisition Capabilities (CAC) are positively related to Innovation in Business Practices (IOPN) in organic food production units.

H1b. Knowledge Acquisition Capabilities (CAC) are positively related to innovation in the workplace organization (IOLT) in organic food production units.

H1c. Knowledge acquisition capacities (CAC) are positively related to innovation in new organizational methods for external relations (NMORE) in organic food production units.

H2a. Knowledge generation capabilities (CGC) are positively related to business practice innovation (IOPN) in organic food production units.

H2b. Knowledge Generation Capabilities (CGC) are positively related to innovation in the workplace organization (IOLT) in organic food production units.
H2c. Knowledge generation capacities (CGC) are positively related to innovation in new organizational methods for external relations (NMORE) in organic food production units.
H3a. Knowledge Combination Capabilities (CCC) are positively related to innovation in business practices (IOPN) in organic food production units.
H3b. Knowledge Combination Capabilities (CCC) are positively related to innovation in workplace organization (IOLT) in organic food production units.
H3c. Knowledge Combining Capabilities (CCC) are positively related to innovation in new organizational methods for external relations (NMORE) in organic food production units.

3. Methodology

The research development process initially involved the adaptation and validation of the measurement and pretest scales, followed by the collection, treatment, and analysis of the data. These stages are described in the next sections.

2.1 Exploratory-Qualitative Phase

Initially, a literature review on knowledge-based dynamic capabilities, organizational innovations, and the organic food market was conducted. There has been a great deal of theoretical work and little empirical research to measure the construct of dynamic capabilities (Eisenhardt & Martin, 2000; Teece, 2007; McKelvie & Davidsson, 2009). To advance the empirical research and validation of measurement scales, this study adopted the following research scales as the most appropriate for data collection:

a) Knowledge-based dynamic capabilities: proposed and validated by Zheng et al. (2011). As defined earlier, this scale has three dimensions that capture the degree to which a company could acquire, generate, and combine knowledge;
b) Organizational innovation: proposed and validated by Camisón & Villar-López (2010). The scale has three dimensions: organizational innovations in business practices; innovations in workplace organization; and new methods of organizing a company's external relations.

These scales had to be modified and adapted considering the language and reality of the managers of the organic agriculture production units. For this, an exploratory study was conducted, based on a qualitative approach, aiming to broaden the researcher's knowledge through the search for information on practical problems related to the research design (Churchill Junior, 1979; Malhotra, 2012). This step was possible considering that exploratory research can be used before quantitative research (Miles & Huberman, 1994). This segment of the research allowed for the collection of information, enabling the adaptation of words and phrases in the measurement items to closely align with the language used by managers and/or owners. The delimited population for the exploratory part of the research comprised actors (producers and processors of plant-based foods, classified as family-owned) located in the rural areas of the city of Porto Alegre – RS. Obtaining data from all actors producing organic foods in Porto Alegre proved to be a challenging task, whether due to a lack of information regarding the number of actors, addresses, costs, or the time required to cover all actors in the region. Thus, one of the solutions is to work with a sample of elements that constitute the whole (Richardson, 1999). In this case, units producing

organic foods located on the tourist route 'Caminhos Rurais de Porto Alegre' and/or actors associated with the Metropolitan Agroecological Network (RAMA) were defined as the sample.

Among the qualitative techniques, a semi-structured interview with 14 questions, Table 1, prepared based on the literature was used, addressing elements that build the dimensions of dynamic capabilities based on knowledge and organizational innovation. Malhotra (2001) mentions that the script makes it possible to investigate the appropriateness of language and the level of understanding of the terms used by the respondents.

Table 1 - Interview Guide for Organic Production Farmers

01	How did the activity with organic production begin?
02	What is the process of managing the production unit/agribusiness?
03	How are information organized, controlled, and stored in the production unit/agribusiness?
04	What changes and/or adaptations have occurred in management techniques or practices in the production unit/agribusiness in recent years?
05	Why were the changes and/or adaptations in management techniques or practices necessary? How were they developed and implemented in the production unit/agribusiness?
06	How is production and product quality control carried out?
07	Is the unit certified? What system is used, and why?
08	Does it employ techniques for effluent treatment, waste reduction, among others? If yes, which ones and when were they implemented?
09	What are the main problems/bottlenecks for making changes and/or adaptations to management techniques or practices in the production unit/agribusiness?
10	How do the employees of the production unit/agribusiness learn about organic production?
11	Do new employees receive training/courses to work in the production unit/agribusiness?
12	Have you (manager/owner) participated in any training courses in recent years? If yes, which ones?
13	Do you participate in field days or technical visits? If yes, please describe.
14	Do you participate in networks (or interact) with other production units/agribusinesses and/or external institutions? If yes, please describe.

The cases were selected through intentional non-probabilistic "snowball" sampling, where the first producer interviewed was asked to indicate another one to respond. The same questions were asked until all the possibilities were exhausted. The criteria were to be the manager of the organic production unit and the researcher's access to the production unit. To determine the number of respondents, the saturation criterion was followed, namely the stage when respondents begin repeating previously obtained content without adding relevant information (Glaser & Strauss, 1967). Nine (09) managers of organic food production units were individually interviewed from November to December 2015. Each interview was recorded and lasted an average of 34 minutes.

During the interviews, observational records were also made in a field diary, along with photographs and videos. These notes helped capture ideas and issues not mentioned during the interviews but rather through informal conversations with the managers while exploring the facilities of the production units. The photographs allowed for the documentation of physical installations, practices, work processes, machinery, and equipment. These data were used as a supplementary source of evidence in the data analyses.

The interviews were transcribed using the naturalized technique, which allows for the literal transcription of the dialogue. This method retains syllabic repetitions, language quirks, and slang present in the recording (Nascimento & Steinbruch, 2019). Subsequently, data interpretation was conducted through the content analysis method using the categorical technique, supported by on-site observations. Content analysis is "a set of communication analysis techniques using

systematic and objective message content description procedures" (Bardin, 2011, p. 44). The results of this analysis were used to adapt and develop the preliminary items present in the original scale.

In the first scale, the construct of dynamic capabilities based on knowledge (Table 2), all the sentences were rewritten, and some words were altered. It was also necessary to exclude the measurement item, "our company can coordinate internal and external networks to effectively combine knowledge," taking precautions not to change the original meaning of the construct. In the second scale, the construct of organizational innovation (Table 3), all sentences were rewritten and adapted according to the data collected in the exploratory phase. Subsequently, the questionnaire's content validity was assessed.

Content validity involves a systematic evaluation of the scale's ability to measure effectively (Hair Junior et al., 2005). For the content validity assessment, in addition to the literature review, the instrument (scales) was submitted to three experts with a Ph.D. in the fields of Administration, Socioenvironmental Development, and Industrial Engineering, selected for their work in postgraduate programs in Brazil, conducting research, and publishing in the field. The experts were contacted and agreed to participate in the process, and communications and adequacy assessments were conducted with them via email. The experts confirmed the appropriateness of the research theory, the questionnaire's comprehensibility, and the technical feasibility of operationalization. They suggested the following changes to the measurement scale of the construct:

- Organizational innovations in business practices – they suggested changing quality management systems to certification and organic inspection systems.
- New organizational methods in external relations with other companies – the suggestion was to replace the word collaboration with cooperation in the item 'we establish collaborative relationships with our consumers' and add the item 'we establish cooperative relationships with other organic producers and/or educational, research, or promotion institutions.'

The recommended adjustments to the questionnaire were made, aiming to address the experts' suggestions. The final wording of the adapted questionnaire is presented in Tables 2 and 3.

Table 2 – Adapted Scale for the Construct of Dynamic Capabilities Based on Knowledge for Organic Agriculture

DIMENSION	VARIABLE DESCRIPTION (question)
Dynamic Capability of Knowledge Acquisition	We could acquire knowledge about technologies for organic production.
	We could acquire knowledge about the organic food market and consumers.
	We could acquire knowledge about property management and/or organic agribusiness.
	We could acquire knowledge about organic food manufacturing processes.
	We could acquire other knowledge about organic production.
Dynamic Capability of Knowledge Generation	We could create knowledge about technologies for organic production.
	We could create knowledge about the organic market and organic consumers.
	We could create knowledge about property management and/or organic agribusiness.
	We could create knowledge about organic food manufacturing processes.
	We could create knowledge about organic production.
Dynamic Capability of Knowledge Integration	We could combine externally acquired knowledge with the knowledge we already possess about organic production and/or agribusiness.
	We could absorb knowledge from different sources and integrate it into our property and/or organic agribusiness.
	We could combine knowledge in different technologies and markets.
	We could combine new knowledge with the set of knowledge we already possess about organic production and/or agribusiness.
	We could adapt processes and internal structure of our property and/or agribusiness to combine the knowledge of organic production and/or agribusiness.

Source: Adapted from Zheng et al. (2011).

The measurement of variables on the scale in Table 2 was done using a 7-point Likert scale, ranging from 'completely disagree' to 'completely agree.'

Table 3 – Adapted Scale for the Construct of Organizational Innovations in Organic Agriculture

DIMENSION	VARIABLE DESCRIPTION (question)
Organizational Innovations in Business Practices	We use knowledge absorbed through experience, lessons, training courses, and workshops.
	We implement practices to develop and improve the well-being of people working on the property and/or in the organic agribusiness.
	We comply with the quality standards required by organic certification and inspection systems.
Innovations in the Organization of the Workplace	We make participatory decisions with other members of the property and/or organic agribusiness.
	We encourage the creation of workgroups within the property and/or organic agribusiness.
	We provide autonomy for people working on the property and/or in the organic agribusiness.
Organizational Innovations in Business Practices	We establish cooperative relationships with our consumers.
	We establish long-term relationships with our suppliers.
	We establish cooperative relationships with other organic producers and/or educational, research, or promotion institutions.
	We outsource activities of the property and/or organic agribusiness.

Source: Adapted from Camisón & Villar-López (2010).

The measurement of variables on the scale in Table 3 was of the 7-point Likert type, where 1 corresponds to 'never' and 7 'very frequently.'

Once the definitive version was developed, a trial application of the questionnaire was performed. The trial refers to the questionnaire test in a small sample of respondents with similar characteristics to the target population, to assess the understanding of respondents and to identify and eliminate potential problems (Hair Junior et al., 2005; Malhotra et al., 2005). The test was conducted with 13 managers/owners who sell their products at the ecological organic food market in Parque Farroupilha in the city of Porto Alegre, Brazil. As the results of this stage were considered satisfactory, the 13 interviews were included in the final database.

3.2 Quantitative Phase

The scales, after being modified and adapted considering the language and reality of the managers/owners of the organic food production units, were as follows:

a) Independent variable: Dynamic knowledge-based capabilities. This construct was measured using a 7-point Likert agreement scale (strongly disagree to strongly agree), as suggested by Zheng et al. (2011). The scale is made up of a total of 15 questions.
b) Dependent variable: Organizational innovation. Construct measured using a 7-point Likert agreement scale (strongly disagree to strongly agree), as suggested by Camisón & Villar-López (2010). The scale is made up of 10 questions in total.

A survey was conducted to achieve the proposed objectives through a structured data collection instrument, applied in ecological organic foods markets located in the metropolitan region of Porto Alegre, state of Rio Grande do Sul, Brazil. The target population of the study was producers/processors of organic foods of plant origin. We chose the properties surveyed in family production units because they range from rural producers who produce fresh food to small agribusinesses that process it.

The questionnaires were applied personally to the managers/owners of these production units from June to November 2016. We collected 161 questionnaires, of which seven were eliminated from the sample because they were incomplete or incorrectly completed. Therefore, the final sample contains 154 questionnaires.

To justify the sample size, GPower3 software was used, which calculates the sample size by providing the power of analysis, confidence level (α) and effect size (f^2). Cohen (2013) recommends that social science studies consider the following parameters for sample calculation: analysis power of 0.80, confidence level (α) of 0.05 and effect size (f^2) of 0.15. For this calculation, the largest number of predictors that a variable can receive must be established, in this case, the total of 3 independent variables (the three dimensions of the knowledge-based dynamic capabilities scale). Thus, the minimum sample required would be 77 respondents. Field data collection totaled 154 cases, which goes beyond the minimum required sample.

Structural equation modeling was used to analyze the data, as it allowed to simultaneously examine the interrelated dependency relationships between latent variables and constructs and between latent constructs (Hair Junior et al., 2005).

Hair Junior et al. (2013) reported the existence of two types of models based on structural equations, namely those based on variance, which do not require data normality, and those based on covariance, which require data normality. The analysis of variance-based structural equations was chosen, i.e. structural equations of the Partial Least Squares (MEE-PLS) type, which seeks to maximize the power of construct determination (Schuster et al., 2016).

This type of analysis was chosen because it proves to be highly effective for small data samples, for maximizing the R^2 (coefficient of determination), and when it is not possible to verify the normality of the data.

For the analysis of the MEE-PLS, several parameters were evaluated to verify if the data fit the model. The first stage included the evaluation of the measurement model, where some types of validity, convergent, discriminant, and reliability were verified; the next stage which includes the structural model evaluation, the path coefficient and the determination coefficient were evaluated. Table 4 summarizes the evaluation parameters for the measurement models and structural model in the two stages of structural equation analysis.

Table 4 - Evaluation parameters used for Structural Equation Analysis

Valuation Type	Validity Type	Indicator
Measurement model	Convergent validity - verifying whether variables are positively related to their construct	Factorial loadings >0.5; Average variance extracted (AVE)> 0.5
	Discriminating validity - Verification if one construct is distinct from another	Larger Crossloads in the original construct; Fornell-Larcker Criteria -> Correlations between constructs
	Reliability	Cronbach α > 0.7 Composite Reliability (CC)> 0.7
Structural Model	Structural Model Path Coefficient Evaluation (β)	T-Value> 1.96 or Sig (p) <0.05
	Evaluation of Coefficient of Determination R^2	R^2> = 0.20 is high in social sciences

Source: (Schuster et al., 2016).

4 Results and Discussion

4.1 Evaluation of the Measurement Model

The model was built based on the following scales: Knowledge-Based Dynamic Capabilities and Organizational Innovations, considering their dimensions as constructs to be verified and analyzed. Once the constituent elements of the model were defined, it was run in SmartPLS v2.0 m3 software, using the criterion "Path Weighting Scheme", which is the standard criterion used in the software.

Other relevant information is that this model can be considered a good model, since the data stabilized with only ten software interactions and has a margin of up to 300 interactions for this adjustment (Hair Junior et al., 2013).

As stated initially, in this study, the constructs are considered as dimensions/factors of the scales, therefore we chose to create acronyms that could represent them in the model and the tests performed, facilitating their understanding and visualization. Table 5 illustrates the constructs of each scale and their corresponding acronyms.

Table 5 - Scales, constructs and acronyms

Scale	Construct / Dimension	Acronym
Knowledge-Based Dynamic Capabilities	Knowledge Acquisition Capacity	CAC
	Ability to Generate Knowledge	CGC
	Ability to Combine Knowledge	CCC
Organizational Innovations	Organizational Innovations in Business Practices	IOPN
	Workplace Organization Innovations	IOLT
	New Organizational Methods for External Relations	NMORE

For the evaluation of the measurement model, the convergent validity was initially verified, which analyzed whether the variables were positively related to their construct, this verification was performed using the extracted mean-variance (SCH) (Schuster et al., 2016). All constructs presented convergent validity, except for the New Organizational Methods for External Relations (NMORE) construct, which presented variables with factor loadings below 0.5 and AVE of 0.29. Thus, the construct was adjusted by excluding the variables with loadings below 0.5, which resulted in the exclusion of the construct, since three of the four variables presented low factor loadings. Table 6 below shows the parameters evaluated for the Measurement Model.

Table 6 - Measurement model parameters for the constructs of the evaluated scales.

Variables	CAC	CCC	CGC	IOLT	IOPN	AVE	α	CC
	Factor loadings							
CD01	0.83					0.66	0.87	0.91
CD02	0.55							
CD03	0.88							
CD04	0.86							
CD05	0.90							
CD06			0.83			0.69	0.89	0.92
CD07			0.87					
CD08			0.84					
CD09			0.80					
CD10			0.82					
CD11		0.83				0.66	0.87	0.91
CD12		0.85						
CD13		0.68						
CD14		0.87						
CD15		0.82						
IO2				0.81		0.65	0.75	0.85
IO3				0.70				
IO1				0.76				
IO5					0.82	0.57	0.62	0.8
IO6					0.89			
IO4					0.71			

Source: Research Data.
Caption: AVE - average variance extracted; α - Cronbach Alpha; CC - Composite Reliability

The next step was the analysis of discriminant validity, verified through the cross-load criteria. The variables need to have higher loadings in their own construct than in the others. For the analyzed data, the criterion was met by the model, which means that it presented discriminant validity. To reinforce this result, we verified the Fornell-Larcker criterion, which states that the square root of AVE must be greater than the correlations between the constructs. The discriminant validity of the model was confirmed according to both criteria and presented in Table 7.

Table 7 - Discriminant validity considering Fornell-Larcker criterion.

	CAC	CGC	CCC	IOPN	IOLT
CAC	**0.81**				
CGC	0.39	**0.81**			
CCC	0.45	0.53	**0.83**		
IOPN	0.44	0.45	0.55	**0.81**	
IOLT	-0.14	0.27	0.21	0.15	**0.75**

Source: Prepared by the authors.
Caption: The diagonal and bold values represent the square root of the extracted variance, and the other values represent the correlations between the constructs.

Summarizing the procedures performed to evaluate the measurement model, we conclude that the measurement model presented convergent and discriminant validity and that all variables presented significant values considering their respective constructs, in addition to factor loadings above 0.50. The reliability of the constructs was also confirmed since all presented Cronbach alpha values higher than 0.6 and composite reliability higher than 0.7. Composite reliability can be considered a superior index to assess validity in the structural equation model (Hair Junior et al., 2013).

4.2 Evaluation of the Structural Model

To evaluate the structural model, the first action was to verify the significance and relevance of the model relationships, performed through the software and the bootstrapping procedure. We identified that some relationships were considered significant at a level of 0.05, i.e., did not present a value higher than 1.96 for T^2. The values of the path (β) and T coefficients are presented in Table 8.

Table 8 - Evaluation of the structural model

			β Original Sample	Standard Deviation	Standard Error	T Statistics
CAC	->	IOLT	-0.33	0.10	0.10	3.42
CAC	->	IOPN	0.24	0.07	0.07	3.47
CCC	->	IOLT	0.19	0.11	0.11	1.75
CCC	->	IOPN	0.39	0.07	0.07	5.29
CGC	->	IOLT	0.30	0.11	0.11	2.86
CGC	->	IOPN	0.15	0.08	0.08	1.92

Source: Prepared by the authors

The next step was the evaluation of the coefficient of determination. The IOLT construct is possibly determined at average levels[3] (R^2= 0.16) by its predictors (CAC, CGC), whereas for the IOPN

[2] In the software used for analysis, the significance verified by sig 0.05 corresponds to T values greater than 1.96.

[3] According to Cohen (2013)

construct the coefficient of determination can be considered high (R^2= 0.40), determined at 0.40 by its predictors (CAC, CCC). This means that the knowledge-based Dynamic Capabilities predictor constructs are good constructs for evaluating changes to the values of the IOPN and IOLT constructs.

4.3 Hypothesis Testing

After the above scale purification process, the structural model presented in Figure 1 was tested.

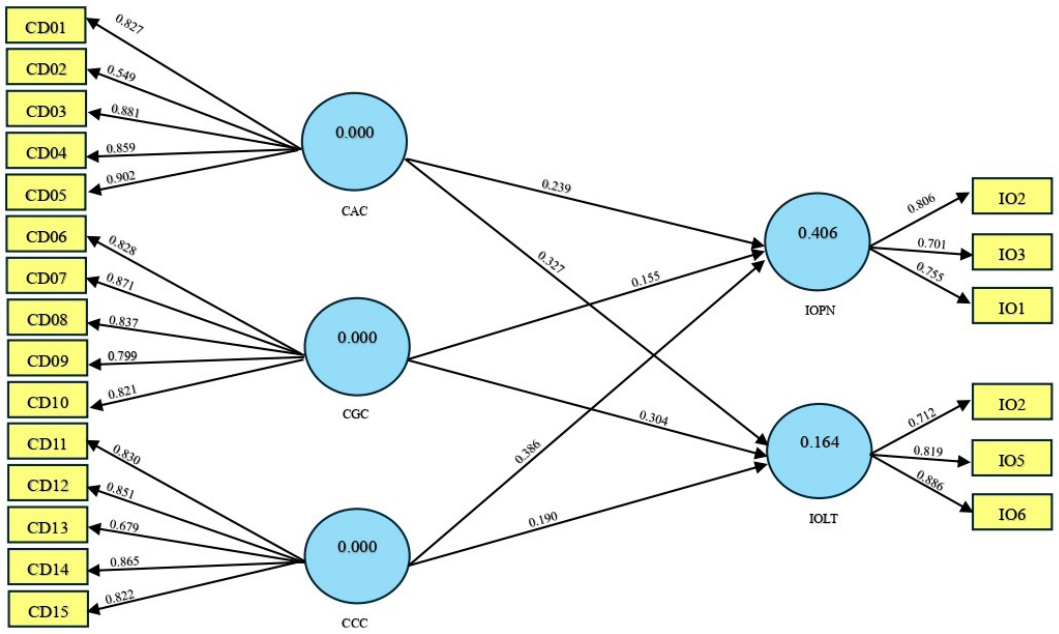

Figure 1 - Structural Model.

The main results of the structural model test and hypotheses are in Table 9. All hypotheses were rejected because the New Organizational Methods for External Relations (NMORE) construct presented variables with factor loadings below 0.5 and AVE of 0.29. Table 9 shows the accepted and rejected hypotheses.

Table 9 Hypothesis tests.

	β	T-Statistic	Result
H1a.	0.24	3.47	Accepted
H1b.	-0.33	3.42	Rejected
H1c.		Invalid construct	Rejected
H2a.	0.15	1.92	Rejected
H2b.	0.30	2.86	Accepted
H2c.		Invalid construct	Rejected
H3a.	0.39	5.29	Accepted
H3b.	0.19	1.75	Rejected
H3c.		Invalid construct	Rejected

H1a: It is possible that the addition of 1 point to CAC increases 0.24 points to IOPN, which supports the proposed hypothesis.

H1b: The hypothesis was rejected because the proposed relationship was positive, and it occurred negatively.
H2a: The existing relationship was not significant.
H2b: By increasing 1 point the CGC increases 0.30 points by IOLT. The hypothesis was accepted.
H3a: indicated that by increasing 1 point the CCC increased 0.39 points in IONP, therefore this hypothesis was accepted.
H3b: The relationship was not significant.

4.4 Discussion

When analyzing dynamic capabilities, it is important to consider that they may have some points in common between different companies, but they are idiosyncratic in terms of the specific ways that companies develop them (Eisenhardt & Martin, 2000). The literature agrees that dynamic capabilities are critical for innovation and competitive advantage, but it is not clear how they contribute to innovation (Zheng et al., 2011). The results support the proposed conceptual model demonstrating the statistical significance of the dimensions of dynamic knowledge-based capabilities concerning the dimensions of organizational innovation. A more meaningful relationship between the dimensions of the construct of dynamic knowledge-based capabilities and organizational innovation occurred between the dynamic ability to combine knowledge and innovation in business practices.

For organic agricultural production units, this dynamic capacity represents the ability to acquire external knowledge (about production, value added to their products, technologies, and markets) from diverse sources and to combine them with the knowledge they already have resulting in new knowledge and new skills. For Kogut & Zander (1992) this process is possible by combining their current capabilities. This dynamic capability is statistically related to innovations in business practices. By promoting this type of innovation, production units can implement processes and activities that allow the resolution of organizational problems, adopt practices for the improvement and maintenance of the people who work in the unit, and facilitate the adaptation of their products (organic foodstuffs) to the required quality standards and certification and inspection systems.

The results show that the organic agriculture production units can acquire knowledge. With this dynamic capacity, production units can acquire knowledge about manufacturing processes, technologies, management practices, and the market in which they operate. It also reveals that these units already have a certain amount of knowledge (Zheng et al., 2011). This finding may indicate that they position themselves favorably vis-à-vis their market environment and seek to explore new opportunities (Makkonen et al., 2014). This dynamic capacity showed a positive statistical relationship with innovation in business practices.

Another dynamic capability identified in the production units was the ability to generate knowledge. This capacity is usually associated with internal R&D (Zheng et al., 2011) and the SECI process (Nonaka, 1994). It is worth noting that in the food industry investment in R&D is low and much of the development of recent technologies comes from external agents (Christensen et al., 1996). In the case of production units, this capacity may be due to the process of socialization through the practice (tacit), sharing (experiences), externalization, and combination (systematization) of knowledge (Nonaka, 1994). It is noteworthy that this dynamic capacity presented the lowest coefficients and significance in its relationship with innovation in workplace organizations.

According to Helfat et al (2007), companies must explore and adapt to changes in their business environment while seeking opportunities through innovations. Considering that the

organic food market has presented growth prospects (Willer et al., 2022), the results of this research show that the organic agricultural food production units have dynamic knowledge capacities that enable them to develop capacities that promote their production, renewing their organizational resources to adapt to market changes.

6 Conclusion

This study aimed to investigate the relationship between the dimensions of knowledge-based dynamic capabilities and the dimensions of organizational innovation in organic food production units. The results show that the research objective was achieved and contributed to the debate about dynamic capabilities and organizational innovation.

While most existing work demonstrates the contribution of dynamic capabilities theoretically (Teece et al., 1997; Eisenhardt & Martin, 2000; Zollo & Winter, 2002; Helfat et al., 2007; Meirelles & Camargo, 2014), this article presents a set of propositions relating dynamic capabilities to organizational innovations. The number of studies on the relationship between these two constructs has increased in recent years. On the one hand theoretical works such as those by Denford (2013) and Panizzon et al. (2015) sought to advance from propositions of analysis frameworks, but eventually showed a lack of uniformity of their concepts and dimensions. On the other hand, previous empirical studies have tried to establish statistical relationships between dynamic capabilities and business performance and approached innovation from a technological perspective, such as Chen (2010) and Makkonen et al. (2014). In the research, delimiting the dynamic capabilities construct only by the knowledge side made it possible to identify and measure the dynamic capacities and facilitated the analysis of the relationship between this construct and the organizational innovations empirically in organic agriculture production units.

No theoretical and empirical studies addressing this theme in agriculture were found. The empirical study of 154 samples of food production units from organic agriculture in Brazil made it possible to fill this gap and contribute to the development of measurement models and theoretical advancement by providing evidence that knowledge acquisition, generation and combination capabilities are important positive determinants for organizational innovation. These results are relevant because they expand current knowledge about dynamic capabilities and reveal their specific effect on each type of organizational innovation (Weerawardena et al., 2006). The approach is groundbreaking in the literature by addressing and broadening the knowledge about the relationship between the two constructs in the field of organic agriculture studies in Brazil.

Practical implications include the importance that dynamic capabilities play in enabling production units to acquire, generate, and combine knowledge resources to exploit the dynamics of their market. Managers should be aware of the importance of dynamic capabilities, and specifically identify and stimulate organizational processes that increasingly allow the development of these dynamic capabilities since the study showed that they are determinants of organizational innovation.

The main limitation of the study is the reduced geographic coverage of the sample, due to the lack of information regarding the number of actors in other regions of the state of Rio Grande do Sul, the location of production units, the cost, and reduced time to cover more regional actors in the sample. For future studies, it would be interesting to apply this approach in a larger sample in different markets in other regions and countries to evaluate the behavior of the constructs analyzed here. Research that seeks to investigate the impact of each dimension on organizational performance should also be conducted.

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