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Realizing dynamic capabilities and organizational knowledge in effective innovations: the capabilities typological map

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Structured abstract

Purpose

This paper aims to shed light on the mechanisms that connect dynamic capabilities and organizational knowledge in the innovative process to offer a new theoretical and practical solution considering the microfoundations of knowledge management strategies.

Design

This research has emerged from an in-depth case study of an effective innovation (from just ethanol and sugar-production to an effective biomass plant). **The study represents an "inductive inquiry," useful to understand specific "organizational mechanisms" of innovation, where the main data came from in-depth interviews with eighteen key actors. It proved to help search the development of a specific biomass plant, designed and implemented between 2000 and 2007 in a Brazilian ethanol and sugar-production large company, referred to here as "Energyplant."**

Findings

This solution provides a new perspective based on the idea that dynamic capabilities are context-dependent and presents an original typological map that shows and materializes dynamic capabilities as teams of human-based resources. **Managerial implications can be drawn from the capabilities typological map highlighting that, although identical dynamic capabilities are not required to change different firms, idiosyncratic dynamic capabilities perform universal knowledge functions that can be mapped, contributing to the planning of a specific innovation.**

Originality

While the dynamic capabilities research has been seen as one of the most vibrant topics in strategic management, scholars have recently stressed that dynamic capabilities continue to be underrated because the knowledge mechanisms that lead to effective innovations have not been adequately explored. The visual mapping is then applied to solve the reviewed theoretical problems, being also suggested to firms interested in change and adapting their capabilities to the requirements of the business environment.

Keywords: Dynamic capabilities; capability paradox; knowledge creation; technological innovation; typological map.

1. Introduction

One of the critical questions in strategic management is being competitive (Ambrosini and Bowman, 2009). For it, firms must adapt and effectively build their capabilities to the requirements of the business environment. How to do it is the big question. The theoretical approach of dynamic capabilities addresses this problem by analyzing the development of firms' capabilities from a dynamic perspective. It allows the identification and construction of sustainable competitive advantages operating effectively in turbulent competitive environments (Eisenhardt and Martin, 2000). In this approach, the dynamic capabilities are understood as the ability of a firm to integrate, build and reconfigure the resources and competencies it possesses to face complex scenarios (Teece et al., 1997).

The research of dynamic capabilities has been seen as one of the most vibrant topics in strategic management (Vogel and Güttel, 2013) but, at the same time, one of the most controversially discussed theories (Di Stefano et al., 2014; Peteraf et al., 2013) due to confusions around the concept itself (Bendig et al., 2018). Since its beginning, different scholars have provided different and successive definitions that have created some misperceptions about its meaning and usefulness (Barreto, 2010). A clear example of it is the divergence of whether dynamic capabilities can be considered as sources of competitive advantage or not (Eisenhardt and Martin, 2000; Teece et al., 1997) and the bifurcated emerged theoretical subdomains that emerged from that controversy (Di Stefano et al., 2014). In fact, despite the considerable growth experienced in this study field, scholars such as Li et al. (2019) or Kurtmollaiev (2020) have recently stressed that dynamic capabilities continue to be underrated because their nature and essence have not been adequately explored. Therefore, research in this area still requires an in-depth examination to make it possible to know how the different combinations of these capabilities influence the business success (Jantunen et al., 2018).

Dynamic capabilities are critical to firms' resilience, facilitating adaptation to turbulent business environments such as the current one derived from climate change (Singh et al., 2021), Brexit, and Covid-19, among others. For example, authors such as Wenzel et al. (2020) suggest that in times of crisis, firms can implement four types of responses: exit, retrenchment, persevering, and innovating. Nevertheless, how organizations can effectively innovate under complex situations remains a big question. To solve that gap, this study explains

how dynamic capabilities could provide more effective innovations from the perspective of organizational knowledge**. Other authors, such as Gonzalez (2021), have used the view of knowledge-based dynamic capabilities to investigate their influence on innovations in Brazilian manufacturing companies. However, these quantitative studies can be enriched with qualitative studies to serve as valuable tools for the managers of these companies. This marriage of knowledge management and dynamic capabilities also required an in-depth scientometric study to lay the foundations of the field, and this has been achieved by Kaur (2022).**

Therefore, considering that research about knowledge-based dynamic capabilities is still in evolving phase (Bindra et al., 2020), this paper intends to find, from an in-depth case study, basic microfoundations of knowledge-based dynamic capabilities (skills, processes, procedures, routines) that drive sensing, seizing and transformation capabilities (Faccin et al., 2019). **This idea has also been recently addressed by authors such as Bhardwaj et al. (2022), who highlighted the importance of studying knowledge-based dynamic capabilities and specific micro-foundations in social purpose organizations.** In order to contribute to the understanding of the microfoundations of knowledge-based dynamic capabilities, we addressed the following research question by using a large Brazilian company as a study case: what are the mechanisms that connect dynamic capabilities and organizational knowledge in the innovative process?

The main objective of this paper is twofold. First, we try to deepen the meaning of organizational capabilities by assessing knowledge as a critical organizational resource. In this sense, we develop, from a grounded theory analysis conducted in a case study, to understand a "taken-for-granted" technological innovation developed in a biomass-plant, a capabilities typological map, which shows the kinds of knowledge that are managed when an organization innovates. The typological capabilities map is theoretically explained and, after demonstrated, as a vivid example, taking the specific innovation case within the energy industry. Second, we apply the typological capabilities map and its main aspects as a repertoire of solutions that scholars can take into account to solve the dynamic capabilities theoretical gaps and by managers when implementing innovations under multifaceted situations.

On the one side, our work contributes to identifying organizational capabilities as teams of human-based resources with idiosyncratic labels, which provide general knowledge functions

and "interdependent products" just when they are demanded, but which can be mapped in a universal way capabilities typological map. In many cases, for example, in turbulent environments, new markets, or lack of resources, some of those teams can be temporary and externally based. This idea suggests the existence of a neglected aspect in the theoretical approach to knowledge-based dynamic capabilities, as they are context-dependent (Bindra et al., 2020). Thus, we can explicitly show how the development and implementation of both permanent and temporary knowledge-based dynamic capabilities lead to effective innovations. Furthermore, on the other side, this research also contributes to expanding the 'organizational drivetrain' metaphor suggested by Di Stephano et al. (2014) as an initial solution to the organizational capabilities field's theoretical bifurcation and reinforces the systemic character of capabilities actuation to provide a competitive advantage as a (manageable) balance between dynamism and efficiency.

The paper is organized as follows. The following section presents the already mentioned theoretical gaps in the dynamic capabilities research. After, we review organizational capabilities complexities and deepen the relationship between these and organizational knowledge to present the typological capabilities map. After the presentation of the map, the methodology applied to the case study is widely explained. Then, as a vivid example, the typological capabilities map is demonstrated, taking the specific innovation case that allowed the map to emerge. In the following section, the paper discusses how the typological map can be applied as a repertoire of solutions to approach theoretical gaps and practical issues. Finally, we conclude and present some future research directions and concluding remarks.

2. Theoretical framework

Capabilities and competitive advantages

Capabilities are central to management and organizational studies since they are related to what organizations can achieve in terms of resilience, growth, and survival. They are crucial to the resource-based view (RBV) of the firm (Barney, 1991; 2001; Peteraf, 1993; Peteraf and Barney, 2003), presenting some aspects, such as complexity, that allow them to offer the VRIN (valuable, rare, inimitable and non-substitutable) conditions of sustainable competitive advantage. In general, capability-based perspectives recognize organizational capabilities as

routines or reliable activities that produce outputs and are subject to market imperfections (e.g., Miller, 2003; Winter, 2000). In this framework, the dynamic capabilities are understood as the ability of a company to integrate, build and reconfigure the resources and competencies it possesses to face complex scenarios (Teece et al., 1997). An example of organizational capability is the coordination and control mechanisms and an illustration of dynamic capabilities when a firm expands internationally and adapts its coordination and control mechanisms to the different competitive scenarios where it is competing. We can find other examples in areas such as marketing (e-commerce), accounting (machine learning), or, like in this paper, production (technological innovation).

While capabilities were usually (and evolutionarily) defined as routines, the capability concept brought shortcomings in change and adaptability (Kurtmollaiev, 2020). This problem originated from the appearance of the dynamic capabilities framework (e.g., Eisenhardt and Martin, 2000; Teece, 2007; Teece et al., 1997; Winter, 2003; Zahra et al., 2006), which attempts to bring greater dynamism to the RBV, a theory criticized for being too static and equilibrium-based (Foss and Ishikawa, 2007; Priem and Butler, 2001). Usually, the dynamic capabilities approach defines capability with more flexible terms, such as, for instance, "a set of current or potential activities" (Teece, 2014: 328). However, at least two theoretical gaps remain unsolved in the dynamic capabilities research.

The first gap is related to the notion that even dynamic capabilities can source both innovation and rigidity (Wohlgemuth and Wenzel, 2016). Putting it as a question, if organizations need dynamic capabilities in order to create, change and restructure ordinary capabilities, what kind of managerial processes are needed to change such dynamic capabilities? In other words, the development of capabilities originates a paradox between dynamism and efficiency (Leonard-Barton, 1992; Schreyögg and Kliesch-Eberl, 2007). Teece (2014: 330) approaches this problem, naming it the problem of "infinite regress," which is "… a process that leads to infinite regress with ever higher orders of capability such that no level of capability can provide a durable advantage". The author's problem arises from "very routine-focused views of dynamic capabilities," which can be solved by including "non-routine managerial actions" in the concept.

However, while it is evident that the actions of managerial teams should be part of the dynamic capability concept, the question about what should change those actions when they become

rigid or outdated remains not answered. This problem was recently stated by Salvato and Vassolo (2018: 1731): "How can these historically-bound approaches to problem-solving, optimized for a context and resource set that is now out of date, address future environmental threats and opportunities"?

A second theoretical gap is the fact that the dynamic capabilities approach also suffers from its subdivision as a "bifurcated domain" (Di Stefano et al., 2014), originating two incompatible subdomains, each one based on distinct seminal papers with contradictory assumptions about nature and purpose of the construct: (1) Eisenhardt and Martin (EM) (2000) and (2) Teece et al. (TPS) (1997). The incongruences between the subdomains bring empirical problems that impede the field from evolving: "without a clear understanding and general agreement over the framework's core, its purpose, and its scope, what guidance is there for conducting empirical research?" (Peteraf et al., 2013: 1396).

The controversy arises from some conceptual differences between EM and TPS about the nature and achievements of dynamic capabilities in firms. Despite both EM and TPS defining a dynamic capability as a kind of routine, the detailing of their conceptualizations reveals central differences about what that routine is and can achieve. EM defines the dynamic capabilities in a simpler sense, as "best practices" or even as "simple roles," and they could not present the power to create a sustainable advantage in high-velocity markets. Differently, TPS visualizes them as complex processes that change the organization's resources and competencies in a sense that the system achieves superiority as capable of producing sustainable competitive advantages even in high-velocity markets.

Trying an initial solution, Di Stefano et al. (2014) propose an "organizational drivetrain" metaphor to unify both mainstreams. They argue that the two different kinds of dynamic capabilities (well-honed and fragile) may work together, with the "best practices" or "simple rules" working as the "front gears" and more complex and structured routines working as the "freewheel", interlinked in a "fully dynamic system". Still, while the drivetrain metaphor clarifies the matter, it is not enough to solve the dynamic capabilities field's bifurcation. First, the metaphor does not define specific robust constructs to be empirically applied. Secondly, when defined as complex or straightforward routines, the dynamic capabilities' main conceptualizations reinforce the "capability paradox" problem reviewed above.

In Figure 1, we show three paths that help us to illustrate the interplay between capabilities, organizational knowledge, and competitive advantages and the neglected mechanisms in those relationships. From the theoretical bifurcation, the relationships between dynamic and ordinary capabilities are not clear (path a) because of the controversies about the nature of dynamic capabilities. When added to the problem of the infinite regress or capability paradox, that problem impedes the explanation of how the relationships between dynamic and ordinary capabilities promote adaptation from the effective balance of new and current organizational knowledge (paths a + b). Consequently, the entire picture of how the stock of organizational knowledge is modified by dynamic capabilities and reproduced by ordinary capabilities to generate competitive advantage (paths a + b + c) is also absent, despite being underlined by López (2005). This call highlighted the use of dynamic capabilities as an essential element in developing knowledge-based assets to create and sustain competitive advantage. Furthermore, this is in line with Zheng et al.'s (2011) approach, where dynamic capabilities are seen as processes that manage knowledge resources and aim to address dynamic environments, i.e., knowledge-based dynamic capabilities enable a better understanding of our results.

INSERT FIGURE 1 HERE

From this vision that we call “the neglected mechanisms," it is possible to highlight that the literature on dynamic capabilities has not appropriately considered important characteristics presented by organizational knowledge: flexibility, subjectivism, and enacting (MacLean et al., 2015; Orlikowski, 2002; Ringberg and Reihlen, 2008). Therefore, it is essential to recover the insight provided by Easterby-Smith and Prieto (2008) or Nielsen (2006). They argued that the link between dynamic capabilities and knowledge management, commonly used in debates about how best to manage organizations in dynamic and discontinuous environments, has not been well articulated in the literature.

Dynamic capabilities and organizational knowledge

Organizational knowledge is considered the main contributor to creating dynamic capabilities and value for the firm (Grant, 1996; Zollo and Winter, 2002). Therefore, considering dynamic capabilities linked to organizational knowledge will bring research on dynamic capabilities a step forward by creating a better understanding of the firm's mechanisms involved in developing and renewing organizational capabilities (Denford, 2013; Nielsen, 2006). The vast

academic literature supports dynamic capabilities are critical to organizations' innovation and competitive advantage (Zollo and Winter, 2002). However, it is not clear how they contribute to innovation (Zheng et al., 2011) or how they can be managed to help organizations be effective innovators under complex situations. For example, how should a textile company deploy its capabilities to change its processes and produce masks in the shortest possible time?

Accordingly, Zheng et al. (2011) set out to clarify the concept of dynamic capabilities from a knowledge-based perspective and investigate the mechanisms of organizational knowledge on dynamic capabilities and innovation performance. Hence, they presented the framework of knowledge-based dynamic capabilities, defined as "the ability to acquire, generate and combine knowledge resources to detect, explore and address the dynamics of the environment" (Zheng et al., 2011:1038). **In recent years, this new field of study has been extensively addressed, proving that the combination of knowledge management and dynamic capabilities can significantly improve organizational competitiveness (Kaur, 2019). Moreover, in a recent literature review, Kaur (2022) highlights that the ultimate goal in the framework of knowledge-based dynamic capabilities seems to be firm competitiveness and organizational performance as well as innovation.**

Knowledge-based dynamic capabilities enable a firm to continuously renew its knowledge base and address changing environments (Ambrosini et al., 2009). Giniuniene and Jurksiene (2005) proposed deepening and explaining the relationship between dynamic capabilities, organizational learning, and innovations. Despite there is empirical evidence that companies seeking to maintain sustained innovation levels must develop dynamic capabilities that allow the simultaneous and continuous creation, absorption, and integration of knowledge (Verona and Rabasi, 2003), Denford (2013) identified the need to synthesize existing research on dynamic knowledge-based capabilities and encouraged further analysis of how dynamic knowledge-based capabilities can influence firm innovation.

Therefore, according to the necessity of reaching a clear and comprehensive meaning of dynamic capabilities (Protogerou et al., 2012), it is essential to study in-depth the mechanisms of knowledge that explain how organizational capabilities (ordinary and dynamic) act to provide new firm innovation. Indeed, Peteraf et al. (2013) claimed the need to develop an integrative framework on dynamic capabilities, as well as Schilke et al. (2018) highlighted the need to explore further those mechanisms (based on organizational resources such as

knowledge) that allow obtaining outcomes from dynamic capabilities. In that direction, we have developed in our study an integrative framework depicted on a capabilities typological map that explains the mechanisms between dynamic capabilities and organizational knowledge in effective innovations.

The typological map: current and new concepts and actions

Our capabilities typological map (Figure 2) was developed from the interlinking between extant literature and the empirical reality, representing the process of innovation as a new grounded theory that "is generalizable insofar as it specifies conditions that are linked through action/interaction with definite consequences" (Corbin and Strauss, 1990: 15). However, we decided to expose it here, before methodology and results, for clarity. We justify it from the advice of Suddaby (2006: 637), who argues that in grounded theory studies, "authors can note that, although they are traditionally presenting theoretical concepts (i.e., upfront in the study), the concepts did emerge from the study".

INSERT FIGURE 2 HERE

From the extant literature combined with the empirical findings, we have specifically used the wide-opened notion that organizational life is formed by "concepts" (conceptual knowledge) and "actions" (empirical knowledge). This dual notion has supported the perception that a routine is composed of "ostensive" and "performative" aspects (Feldman and Pentland, 2003) and was deeply explored by the study about innovation conducted by Hargadon and Fanelli (2002), which showed that organizational knowledge is formed by "latent" knowledge and "empirical" knowledge, which are inseparable, but distinct. Moreover, considering that knowledge can reinforce or break routines and capabilities (Leonard-Barton, 1992), the explanation of innovation should be searched in the specific "interplay" between latent and empirical knowledge: on the cyclic interaction between the two, between the 'energy' that resides in latent knowledge and the 'matter' of empirical knowledge (Hargadon and Fanelli, 2002: 300).

Following Teece (2016: 204), who points out that "the most important analytical distinction among capabilities is that between ordinary and dynamic", ordinary capabilities are associated with current knowledge reproduction, and dynamic capabilities are associated with new

knowledge production. Therefore, the map respects the assumption that organizational capabilities present both the conceptual knowledge (the vertical axis) and the empirical knowledge (the horizontal axis), both varying among current (routines) and new (innovative processes). Each of the two dimensions (conceptual knowledge and empirical knowledge) can be subdivided into current and new, simplified degrees of novelty related to the explorative-exploitative possibilities of organizational learning (March, 1991), forming four types of capabilities on the map.

Basing our reasoning on the notion that a capability is a team of resources accomplishing some task or activity (Grant, 1991), implicit in the typological map is the definition of a capability as a team of human-based resources, "labeled" by their participants as a necessary social interaction to deploy other types of resources to produce or reproduce desirable knowledge outputs. Depending on the type of capability, sensing, seizing, transforming, or ordinary (Teece, 2007, 2014), the outcome varies with new symbolic knowledge, new products and/or processes, new routines, and current routines. Then, the map associates the typology of organizational capabilities exposed by Teece (2007; 2014) to specific kinds of knowledge and outputs, linking distinct theoretical domains and the empirical reality following the "theory construction as disciplined imagination" (Weick, 1989).

From the map, capabilities with distinct functions can work simultaneously. However, to innovate, an organization must perform all four types of capabilities. So, (1) "ordinary capabilities" mark the beginning and the end of innovation, representing the routines before and after the actuation of dynamic capabilities. Providing the learning and the building of new concepts, (2) "sensing capabilities" are specialized in the "scanning, creation, learning, and interpretative activity" (Teece, 2007, 1322), creating new symbolic knowledge (e.g., market information and plans), but without altering the resource configuration that will support new routines. That new symbolic knowledge nurtures new actions through the (3) "seizing capabilities", wherein there is the development of new resource configurations in the form of "(…) new products, processes, or services" (Teece, 2007, 1326). Therefore, together, sensing and seizing capabilities "think" and "test" innovations in a trial-and-error and experimentation fashion. Because those innovations also have to supply markets (Pavitt, 2002; 2005) and so have to be routinized in the organization as a system, the (4) "transforming capabilities" incorporate the (conceptually) tested innovations to the ordinary capabilities, providing the "(…) asset-realignment activities and the revamping of routines" (Teece, 2007, 1336). This can

happen in processes or products that substitute the old ones or accumulate old and new processes and products in the organizational portfolio as the organization migrates from the sensing to the transforming dynamic capabilities, both the commitment and the irreversibility of resources invested in an innovation raise.

Finally, the map is based on the notion that "all learning takes place inside human heads" (Simon, 1991: 125). However, collective behaviors are necessary because, in dynamic capabilities, there is the prerequisite of the existence of collective connectivity in the form of "productive dialogue" (Salvato and Vassolo, 2018), a mode of interaction that "trains employees with different backgrounds in everyday skills for collaboration, such as running a meeting, listening, leading a team, and making group decisions" (Salvato and Vassolo, 2018: 1743). In other words, the proposed map represents "patterns in events" (Langley, 1999: 692) and so is a kind of "process" theory, aiming for "analytical generalization" (Yin, 2003). Moreover, as a complex picture, the capabilities work on the map in a "distributed" form (Buchanan et al., 2007; Giddens, 1984; Tsoukas, 1996; Tsoukas and Chia, 2002), wherein functionally overlapped capabilities (i.e., hybrid) are expected to be common.

3. Research methodology

Selection and research design

Given the concerns mentioned above and the need to deepen the microfoundations of dynamic capabilities and their interplay with organizational knowledge in implementing effective innovations, we undertook a "phenomenon-driven" case study (Eisenhardt and Graebner, 2007: 26). The study represents an "inductive inquiry," useful to understand specific "organizational mechanisms" of innovation: "mechanistic explanations provide a systematic and needed way to render various processual organizational phenomena more intelligible" (Pajunen, 2008: 1450). It proved to help search the development of a specific biomass plant, designed and implemented between 2000 and 2007 in a Brazilian ethanol and sugar-production company, referred to here as "Energyplant."

The investigated station produces and exports electricity by burning the sugarcane-processing waste product, also selling carbon-credits associated with the Clean Development Mechanism

(CDM), one of the Kyoto Protocol institutionalized carbon market mechanisms. Before the innovation, Energyplant had not sold electrical energy. Therefore, this particular technological innovation provided the firm with a new process (conducted in a new computer-based energy plant), producing new products (i.e., traded electricity and carbon credits).

Founded in 1980, Energyplant is a sugar, ethanol, and energy producer in a fragmented Brazilian industry of about 400 firms. In the harvest of 2007/08, this firm had a workforce of 2,500 employees and an operational revenue of around US$ 80,000,000. The company is vertically integrated, producing and processing its sugarcane through continuous technologies. The company's processes and lines of products show a variety of quality and environmental certifications, including those from USDA (United States Department of Agriculture) Organic, ISO 14001, and Organic JAS (Japan Agricultural Standard), allowing the company's presence in international markets. The company is family-based, with several higher managerial positions and the most significant proportion of shares being held by family members. Since 2008, the firm has grown, and in the harvest of 2020/21, its sustainability report described a workforce of 3,937 employees and a revenue of around US$ 270,000,000.

The investigation was concentrated on the emergence of high technology: a computer-based energy generation station, developed between 2000 and 2007 (inaugurated in 2003). The development, start-up, improvement, and operation of the energy generation station should be understood as three interrelated innovations that changed the firm's "technology cluster" (Rogers, 2003: 14). The first and most radical innovation involved the electricity-production equipment, wherein electro-mechanical turbines and generators were replaced by computer-based ones. That replacement not only involved investment in equipment but also in civil construction, technical training, and engineering consulting, allowing Energyplant to transform itself from a non-energy exporter in 2000 to an exporter of 43,000 MWh (Megawatt hours) in the harvest of 2004/05 and 76,300 MW-h in the harvest of 2008/09. Secondly, based on the exportation of electricity, the company could commercialize its carbon credits by engaging with the Clean Development Mechanism (CDM) between 2001 and 2012. Thirdly, the company also substituted diesel-fueled irrigation motors and equipment for those running on electricity. This substitution extended the area of plantations covered by electrical irrigation from zero in 2000 to around 35% in 2008. The use of electrical irrigation equipment saves costs, avoids carbon emissions, and reduces irrigation shut-offs and noise.

The investigated innovation contributed to the high performance that Energyplant currently presents. During the investigation, during the interviews, some managers reported that they were working on constructing a "new unit," using the "learned lessons" from the innovation. This new business strategic unit was inaugurated in 2011, focusing on energy production (ethanol and electricity), contributing to raising profits, and positioning the firm as an environmentally friendly player. In 2015 and 2017, the Energyplant built two joint ventures to own and manage its electricity exportation with a global player in the renewable energy industry, temporally selling the majority of its electricity apparatus to the global partner. From that partnership, in 2015, Energyplant also started to burn the sugarcane straw to generate electricity. In 2021, the company opened its capital with its first IPO, selling US$ 95,000,000 of "green bonds" with success. In the most recent 2020/21 harvest, the net income of the entire company was around US$ 36,000,000, more than double the net income of the 2019/20 harvest. Part of those profits, around US$ 2,400,000, came from the participation of the Energyplant in the two-energy exportation joint ventures.

Data gathering and analysis

The information was collected in 2008 and 2009 through in-depth interviews conducted to investigate the organizational mechanisms involved in technological innovation. According to Ma et al. (2020), interviews are a fundamental method for collecting data about business managers. In our case, that effort involved eighteen key actors (Table 1), chosen from the "snowball sampling" technique to access the "hard-to-reach" (Handcock and Gile, 2011: 3) innovators, wherein the first interviewees indicated other employees and other organizations, according to their relatedness to the innovation. Three organizations were covered: Energyplant, the consulting firm linked to its CDM project, and one of the Brazilian Agencies in charge of this type of carbon project. Even though the research results mainly emerged from the interviews from Energyplant, the interviews in the CDM consulting firm and the Brazilian Agency were important to understanding the specific context of the case and understanding how external actors interact with internal members in externally based capabilities. Those procedures were in accordance with the notion that, in the case studies, multiple informants from distinct functions, hierarchical levels, geographies, and organizations contribute to avoiding bias by bringing diverse perspectives into a convergent theoretical building (Eisenhardt and Graebner, 2007: 28).

The interviews focused on the emergence, operation, and consequences of the new energy station, **supported by interview protocols (one for each organization), which in line with Singh et al. (2021), contained questions about the nature and role of the individuals, groups, activities, capabilities, and resources that promoted the innovation.** The interviews lasted an average of 49 minutes, with a mean deviation of 15 minutes among them. They were all recorded and transcribed verbatim, resulting in a document of 202 pages of single-spaced text.

INSERT TABLE 1 HERE

The data analysis was based on the grounded theory approach (Corbin and Strauss, 1990; Corbin and Strauss, 2008) to allow the development of theoretical explanations based on an appropriate empirical reality. The analysis was carried out using the grounded theory main techniques of open-coding, axial-coding, and theoretical integration. For the analysis of the interviews, open-coding for incidents (represented by sections taken from transcripts) was used as "key anchor points" (Langley, 1999; Pozzebon and Pinsonneault, 2005), so that categories emerged as robust meanings and patterns of interactions related to the innovation.

After, those categories were re-analyzed considering the microfoundation's point of view (Teece, 2007) in such a way that they would form a hierarchy of categories and subcategories (axial-coding). From an analytical purposed, dynamic capabilities can be disaggregated into the capacity (1) to sense and shape opportunities and threats, (2) to seize opportunities, and (3) to maintain competitiveness through enhancing, combining, protecting, and, when necessary, reconfiguring the business enterprise’s intangible and tangible assets (Teece, 2007: 1319). In fact, the most important categories are the case-specific (and labeled) organizational capabilities (dynamic and ordinary): environmental scanning, strategic management, engineering consulting, assembling task forces, watched operation, the final computer-based technology, and the replaced electro-based technology, organized in Figure 3. The legend indicates the figure trace of each capability, indicating if they were temporary (replaced or existent just to provide the innovation) or are permanent.

INSERT FIGURE 3 HERE

From the combination of those categories and theoretical insights, it was possible for the emergence of a *core category* in the form of the capabilities typological map, which situates the discovered case-specific dynamic capabilities into their "functions," mixing empirical evidence with previous (knowledge-based) theory in a "theoretical comparisons" effort (Corbin and Strauss, 2008: 74-77). From that discovery, four interviews with managers significantly related to the innovation were re-analyzed, easily achieving the "saturation" (Corbin and Strauss, 2008: 145) of the proposed map as a "theoretical integration ."Table 2 presents how a robust number of excerpts (incidents) of the four re-analyzed interviews reinforced the case-specific dynamic capabilities and how these dynamic capabilities "fit" the knowledge functions that classify them into the three main kinds of dynamic capabilities of the map. It provides replicability to the study and is supported by both the final researcher "memos" (i.e., the discovered knowledge-based characteristics of the kinds of dynamic capabilities) and "diagrams" (i.e., the typological capability map), which are tools that "grow in complexity, density, clarity and accuracy as the research progress" (Corbin and Strauss, 2008: 118).

INSERT TABLE 2 HERE

The interviewed managers and employees were aware of the capabilities below described as actuating in the innovation, as well as their activities and outcomes, therefore satisfying the "performance," "cognition," and "action" dimensions in capabilities identification (Grant and Verona, 2015: 67). Some said "labels" of the capabilities identified were just adjusted to fit better their academic representations. For example, the label "strategic planning" was adjusted to "strategic management" since it became clear in the analysis that it also involved meetings to implement and control plans.

The form that the typological map happened in Energyplant is presented in the next section, together with representative vignettes of the interviews. The reader may check these for accuracy. This kind of procedure follows a "constructionist" character of grounded theory (Charmaz, 2000: 510), which "recognizes the mutual creation of knowledge by the viewer and the viewed."

4. Results

According to the theoretical capabilities typological map formerly presented in this section, the effective innovation case in Energyplant is detailed. As we are arguing, to be helpful in management and organization studies, specific capabilities, idiosyncratic in each case, can be mapped and plotted according to their functions, as labeled by organizational members or academicians. Therefore, how the organizational capabilities actuated to provide an effective innovation in the Energyplant can be mapped and visualized in figure 4. As indicated by the legend, while "engineering consulting," "watched operation", and the "initial electro-mechanical technology" was temporary, ending after the innovation, the other capabilities remained working after.

INSERT FIGURE 4 HERE

The results presented below to reinforce the findings of the recent case study of Faccin et al. (2019), which also identified knowledge-based dynamic capabilities related to an inter-organizational innovation, classifying them as the sensing, seizing, and transforming types. However, our results also expand their findings by describing, in a typological map, the types of knowledge (i.e., conceptual, empirical, or both) that each type of knowledge-based dynamic capabilities generates, therefore contributing to consolidating the knowledge-based dynamic capabilities research mainstream.

In this successful innovation experience, the organization first started from the ordinary capability of the "initial" electro-mechanical sugarcane waste processing (that was replaced). At the same time, organizational members and external consultants learned, externally and internally, from the sensing capability of "environmental scanning" about the physical characteristics of the firm, new brand equipment, possible sources of financing, and the energy and carbon markets. From that knowledge, organizational members and consultants could, after combining them, create new strategic plans through the "strategic management" sensing/seizing/transforming capability and create technical and carbon-trade projects through the “engineering consulting” sensing capability. Then, those plans and projects were implemented with the support of the "assembling task forces" seizing capability, which resulted in a new (computer-based) technological "line". The new technological line also started working due to the actuation of the “watched operation” transforming capability, which allowed the development and routinization of new processes, originating the ordinary capability of the “final” computer-based technology, which provides energy and carbon credits

exportation as new routines. Below, the actuation of the sensing, seizing, and transforming dynamic capabilities are explained in detail.

Sensing from the environmental scanning, strategic management, and engineering consulting dynamic capabilities. The dynamic capability that initiated the innovation was "environmental scanning", which provided learning about new external and internal knowledge. More specifically, the idea of a new energy station resulted from the perception that both the Brazilian equipment suppliers and electricity markets were favorable to that kind of endeavor. As stated by the Environmental Manager:

The process was initiated in 2001. How it began? The plant, it cogenerates by nature. Every [sugar and ethanol] plant cogenerates energy. But it was not allowed to you to sell energy. The [Brazilian energy agency] did not allow you to get your energy excess and commercialize it, ok?… Then, what happened? In 2001, this scenario started about changing.

Verily, that new "scenario" started in 1995 when the **Brazilian energy market changed due to the creation of laws that allowed "the independent energy producer. To realize that new scenario,** Energyplant managers performed routines of "environmental scanning," mainly based on the scrutiny of specialized media, but also related to another sensing dynamic capability, the "engineering consulting":

In fact, we have consulting services… we have consulting on the [sugar and ethanol] process and on the energy generation. And, we also can say, from the literature, we read journals of the sector, we go to workshops, we recycle [the ideas], we go to suppliers, in fact, there are many people in the same direction [i.e., innovation].

Moreover, the accumulation of existing knowledge was also about the internal routines of the firm, since the strategic managers realized that the old material apparatus of the firm was obsolete and insufficient to guarantee its growth. As the industrial manager pointed out:

When in 2000 we showed that the plant had the possibility of generating a surplus of energy and commercializing that surplus, he [the director] thought the idea was interesting… In fact, we had the necessity of implementing another generator; we had a deficiency of internal generation to supply the own firm. So, together with the implantation of this generator, we took

advantage of this effort of implanting another generator and, beyond that, to have a small energy surplus.

The vignette above transmits the notion that the "environmental scanning" capability was the connection of multiple individual actions. An isolated manager could learn an important novelty alone; however, it became a capability just when decision-makers shared and discussed this novelty. Moreover, sometimes the “environmental scanning” worked through temporary teams that collected dispersed information, as was the case when the firm needed to obtain and transmit data to a consulting firm to design its CDM project. All those external and internal-oriented learnings were important to the innovation, forming the base for the "strategic management” and “engineering consulting” capabilities, which designed strategic plans and technical engineering projects as symbolic knowledge. According to the Industrial Manager, the creation of strategic plans facilitated the coordination of responsibilities and the estimation of the "viability" of the investment:

You cannot enter a game like this without an economic viability plan. There are contracts. For example, in the case of the energy generation... what allowed the making of the investment was having the guarantee of contract for 12, 10 years with the [electricity buyer/distributor company].

Indeed, variations of the statement "everything started in the strategic planning" were heard in most interviews. According to the Industrial Manager, the technological modifications were taken into account in the strategic planning because they involved the allocation of expensive resources and presented a systemic character, which affected many areas and, therefore, should be coordinated and negotiated by plans:

To you generate energy, you need sugarcane, in the harvest... we needed to increase the processing and, consequently... you generate impact in other areas. To attend the energy, we made a planning from 2002, we made an action plan. It needs to increase sugarcane, it needs to increase the distillation, the fermentation.

Technical projects and strategic plans combined both firm-specific and external knowledge and were based on the accumulated experience of both managers and consultants. Especially, technical projects were useful to describe a new technology from the combination of internal

and external previously existent artifacts, which should be combined to form a new energy station.

***Seizing from strategic management and assembling task forces*. In Energyplant, it involved the implementation of new plans and technical projects to build a new technological "line" in the form of a new computer-based energy station and the starting of this new station.** In that effort, there was the exercise of managerial and financial power (i.e., investments) by the "strategic management," a dynamic capability that actuated together with the "assembling task forces" capability to provide a new computer-based energy generation plant.

Organizational members used "assembling task forces" to translate new latent knowledge (i.e., new technical projects and strategic plans) into new empirical knowledge represented by new technological objects (i.e., a new computer-based station composed of new artifacts). In this context, plans and technical projects provided "guiding" "referring", and "accounting", **emphasized by Feldman and Pentland (2003) as the roles of the ostensive aspect of routines. In Energyplant "assembling task forces" allowed the implementation of plans** and technical projects and the creation of new cognitive and real connections between people and technological objects.

Those task forces joint people from complementary backgrounds and areas to perform such a complex task. Managers and workers who should operate the new technology machines joined people from suppliers and the maintenance, electrical and mechanical departments in assembling task forces responsible for understanding and solving mechanical and electrical problems about "installation". Below, the Industrial Manager explains that again:

These kinds of investments are heavy, and so the director board has to approve... And, in the implementation, where we must have an expansion, let's guess that it is in the sugar fabric, so the manager of the sugar fabric is completely related to that implementation. Because he will operate the machines, so he is the responsible to the implementation. The Electrical and the Mechanical departments will support him, but he check the terms...

Of course, in the quote above, "he will operate the machines" means the responsibility of a manager over a complex technology. Therefore, "assembling task forces" contributed to

develop a new process and its new products (i.e., energy and carbon credits), providing not just new technological objects/artifacts but also human training. This fact can be realized from the answer of the Energy Utilities Coordinator when asked about the consequences of the new energy station to his professional life:

I supervised the assembling, made the assembling, and augmented my knowledge… When you assemble an equipment, you know all that equipment. It is different from the person that goes inside there and gets that already functioning. [The person] does not know something that I know: the matter of the foundation, the matter of the assemblage, the material that was used, why that material was used.

Transforming from strategic management and watched operation. Despite "assembling task forces" providing human training, the "watched operations" capability augmented the reliability of that human training to perform the new process. "Watched operations" meant multidisciplinary teams composed of suppliers (sometimes auditors) and employees of the Energyplant, aiming for a safe starting of a new process and its posterior routinization. Therefore, "watched operation" actuated as a transforming capability, creating a new process and transforming the firm to arrive at new routines. **The investigated technological innovation changed the job conditions of many managers and operators since Energyplant conducted internal selection to allocate appropriate employees to the positions required for the new energy station.**

"Watched operations" were also controlled by strategic managers, overlapping with the "strategic management" dynamic capability. Specifically, in Energyplant, the "watched operation" was marked by the interaction between organizational members and new equipment through training lessons given by equipment suppliers and auditors, which also meant a "temporary" dynamic capability. The Industrial Manager described that operation:

We already buy the equipment with this training… Then, the supplier comes, assembles the equipment, then we make the start-up… make the tests, the conditioning of the tests, start the machine, and, keep 15, 20, depending on the machine, 30 days, in watched operation. That is training because he [the supplier] has to train the people of a turn, the second turn, and the third turn. We have to reserve that people to extract the knowledge of the machine. When a new machine appears, a new technology, a piece of new knowledge emerges inside the industry.

In the piece above, "to extract the knowledge" means the practical understanding, by technology users, of the "functional proprieties" related to the machine guessed by their developers (Kroes, 2010). Those performances are related to new materials conversions allowed by the development of tacit knowledge by technology operators and managers through learning-by-doing and learning-by-interacting. That development of this new tacit knowledge to perform new technological routines can be observed in the piece below, in which an Energy Facility Operator explained how he obtained the necessary skills for his job:

Then I came here, and I learned from the operator that already worked here in this area… [The operator] showed me everything of the turbine and the generator, which were the knowledge that he had… Then, he spent a period passing to me the information, and after this period I started doing and he was looking… I usually said: "now, I will do it, and you keep looking because maybe I do wrong…".

If there was something "wrong" to be avoided, it is because the technology needs to be sociomaterialized by practice to be reproduced in a socially acceptable sense. In Energyplant, when a worker was "transforming," he or she was not just extracting from the "structural (physical) proprieties" of technological artifacts, their previously guessed "functional proprieties" (Kroes, 2010). In addition, that worker was also coordinating his or her activities and outcomes with other colleagues and parts of the organization. We argue that the high demand for trustable reproduction of the technology is due to the high connectivity between its components and between its outputs and systems surrounding it (Boudreau and Robey, 2005; Pavitt, 2002; 2005), observed in the new computer-based ordinary capability of energy and carbon credits production and exportation, established in Energyplant.

Therefore, while the evident focus of the "watched operations" was the performance of a new process and the delivery of new products, in fact, they tried to achieve new reliable routines, in a sense that the new ordinary capability of "computer-based energy exportation" came to the existence, replacing the previous "electro-mechanical technology" that had no energy exportation. In innovation, transformation ends when new routines characterize the essence of social systems: "reproduced relations between actors or collectivities, organized as regular social practices" (Giddens, 1984: 25). Our results reinforce Zollo and Winter's (2002) assertion that experience accumulation and knowledge codification are crucial parts of organizational learning.

5. Discussion

In this section, we discuss the theoretical contributions of the capabilities typological map to overcome the paradox and bifurcation gaps of the dynamic capabilities research, introducing the knowledge-based perspective (Zheng et al., 2011). We also comment on their practical contributions to **managers and expand directions for future research.**

Theoretical implications

The contributions of the study to solving the capability paradox are twofold. First, by considering a capability as a team of human-based resources that accomplishes knowledge functions, the typological map opens space to realize some temporary and usually externally oriented collective processes as capabilities, which may be managed just when their knowledge outputs are necessary. Putting it differently, temporary dynamic capabilities can represent the last level to solve the "infinite regress" problem: they are invested by the organization to innovate the entire organizational system, combining the occasionally created with the previously existing internal knowledge. The notion of "temporary capabilities," despite very rare in the dynamic capabilities' literature, is not new. For instance, the simple notion that any capability has its "lifecycle" (Helfat and Peteraf, 2003) allows the existence of short-time capabilities. However, our study clarifies that temporary capabilities accomplish valuable knowledge functions, bringing dispersed concepts of the dynamic capabilities' literature, such as, for instance, the notion of "temporary network development capability" (Pérez-Nordtverdt et al., 2013), into the same capability construct.

From this reasoning, there is no paradox because any organization can break the inertia, injecting new knowledge into the organizational system through temporary capabilities. This was the case, for example, of the "engineering consulting" capability, which was managed temporally, just to provide new technical and carbon-trade projects for a new biomass technology.

These results are also in line with recent research such as Bindra et al. (2020). They stated that in the current competitive context, where knowledge-based economies are experiencing unpredictable and innovative demands, companies must focus on strengthening knowledge-

based dynamic capabilities to sustain their performance. In fact, "the mechanism underlying knowledge mechanisms entails both internal and external activities related to knowledge-based on collaborative efforts and networks" (Bindra et al., 2020: 275).

Second, the capability definition behind the typological map also admits more (manageable) flexibility to any capability, especially the dynamic ones. If capabilities are defined by human-based resources to accomplish knowledge functions and not by repetition, the approaches explain that routines and capabilities can change from the inside (e.g., Feldman and Pentland, 2003; Helfat and Peteraf, 2003) to become stronger. We can observe, from our study, that it is possible to change the resource configuration and outputs of a dynamic capability, even though its function and label remain the same. For example, in Energyplant, the "assembling task forces" capability has its label and function, which is very stable: it is a seizing capability necessary to implement technology projects. However, those implementations' specific contents change from one innovation to another, as well as some persons who participate in that dynamic capability, and this high dynamism does not impede its manageability. There is no paradox from this reasoning since organizations can break inertia by constantly investing in capabilities with stable labels and functions to change their specific knowledge outputs and resource configurations to provide sequential innovations.

Addressing the bifurcation of the capability field, the created theoretical typological map reinforces and expands the "organizational drivetrain" metaphor suggested by Di Stefano et al. (2014) as an initial solution to the organizational capabilities field's theoretical bifurcation. The typological map acts as a dynamic system in which the two types of mechanisms (simple rules and complex routines) are part of it: both are manageable "units" that are essential to innovation, despite if they can be labeled differently from case to case. From the map, it is also possible to visualize that those dynamic capabilities labeled as specific "best practices" - a conceptualization close to Eisenhardt and Martin (2000) perform the general sensing, seizing, and transforming (knowledge) functions – an evolutionary conceptualization closed to Teece et al. (1997), contributing to unify the two mainstreams, to solve the bifurcation. Putting it in simpler words, an organization can use many kinds of "labeled" capabilities to innovate, for instance, temporary and/or permanent, as well simple (EM) and/or complex (TPS), if they contribute to filling the entire typological map, performing all sensing, seizing, transforming and ordinary knowledge functions. This is enabled by considering the deployment and

development of knowledge resources as a microfoundation of dynamic capabilities under the view of knowledge-based dynamic capabilities (Bendig et al., 2018).

Moreover, the applied typological map also contributes to the understanding of the dynamic competitive advantage because it shows the actuation of a myriad of simple and complex capabilities to provide valuable functions linked to the introduction and profitability of novelties in markets, reinforcing the systemic character of capabilities actuation to provide a systemic competitive advantage (figure 1). It is interesting to see that, in the Energyplant case, the “strategic management” capability was used to manage other capabilities (and the organizational knowledge). The entire system could achieve a competitive advantage. Future research can provide valuable insights by focusing on the strategic management capability as a high-order dynamic capability that manages other ones.

Managerial implications

From a practical sense, since the map shows how a "product" produced by a knowledge-based dynamic capability (e.g., a technical project) was necessary to produce another product in another dynamic capability (e.g., a new technological "line"), it can support the specification of necessary capabilities before an innovation. This aspect connects with the survey about the determinants of innovation in firms developed by Jensen et al. (2007). They use some indicators (e.g., the use of autonomous groups) that indicate the existence of temporary dynamic capabilities. They show that the combination of experimentation with scientific (and specialized) knowledge and flexible and temporary activities based on tacit (and diverse) knowledge raises innovation potential. It could be relevant to study if those 'modes of innovation' demand specific dynamic capabilities that permit the completion of the knowledge functions' typological map. In other words, the typological map can be used as a planning tool.

Moreover, since temporary dynamic capabilities were also identified, our study also suggests that organizations should focus on “developing” people, especially the capacity of individual managers to perform physical and mental activities (Helfat and Peteraf, 2015). Through developing people, organizations can build (some) knowledge-based dynamic capabilities just when they are necessary. For example, since internal and external connectivity favors the development of dynamic capabilities, providing external experiences and broader participation of managers and employees in decision-making may improve organizational members'

willingness to innovate products through a mechanism based on microfoundations of dynamic capabilities (Faccin et al., 2019).

Finally, Vergne and Durand (2011) suggest that a company's endowment of capacities is cumulative and that its effectiveness in change processes depends on the requirements that these processes demand. In our case, we have seen that the firm uses its dynamic capabilities for the three basic functions of detecting, exploiting, and reconfiguring, but with unequal intensity. That is, identical dynamic capabilities are not required to change a textile firm's processes to produce masks in the shortest possible time than to deploy a cogeneration plant. Also, we have seen some of the mechanisms by which the resource base of a company has changed, and as a result, a specific outcome has been obtained (the cogeneration plant). This result could be considered intermediate, positively influencing the firm's income statement and profitability.

Suggestions for future research

In a nutshell, we have noted that the universal knowledge functions of dynamic capabilities are about developing organizational knowledge: new concepts that support new products and/or processes, which have to be routinized after as reliable new routines. Some capabilities are externally oriented and even temporary. In contrast, others are internal and permanent, and the competitive advantage comes from the entire system of capabilities developed by an organization in a certain period. At the same time, an approach to the strategic management of the company may be valid to perform these three functions generically, thus acquiring the credential of higher-order dynamic capability, which raises the need to combine it with other lower-order dynamic capabilities more closely related to other organizational areas of the company such as HRM. From that more operational level, it will be possible to be more effective in systemically solving problems and detecting and capturing opportunities.

Future research can focus on the study mentioned above of the strategic management capability and test and extend the developed model, quantitatively and qualitatively. The power of orchestration of the strategic management dynamic capability can be tested under different environmental conditions (Wilhelm et al., 2021) and different modes of innovation, more based on codified scientific and technical knowledge or informal learning processes experience-based knowledge (Jensen et al., 2007). We expect this kind of testing to show other innovations,

marked by other capabilities, differently labeled; nevertheless, the typological map will show similar knowledge management.

6. Conclusions

This paper's objective was to realize the interplay between organizational capabilities and organizational knowledge in an effective innovation from a microfoundations point of view. This research has deeply explained the theoretical literature regarding dynamic capabilities and focuses on knowledge-based dynamic capabilities by analyzing a vivid case study to achieve this goal. This approach has allowed us to control the object of study (an effective innovation) and the agents in charge of its implementation (managers) to focus our analysis on the actions or organizational changes carried out.

Built from the interlinking between empirical data and extant literature, an original capabilities typological map was developed to show that relationship, also serving as a repertoire of solutions to overcome the insistent theoretical gaps in dynamic capabilities research. Considering a capability as a team of human-based resources with knowledge functions, our study showed that, in organizations, high flexibility remains manageable through labeled dynamic capabilities that aim to produce new knowledge from necessary human connectivity. Since, from the typological map visualization, dynamic capabilities were identified as labeled "units," even so presenting universal functions and therefore being passible of "variation" and "selection," our study contributed to conciliating the evolutionary and the "cultural" mainstreams (Nelson, 2006), offering guidance for firms adapt and effectively build their capabilities to the requirements of the business environment, to increase their competitiveness.

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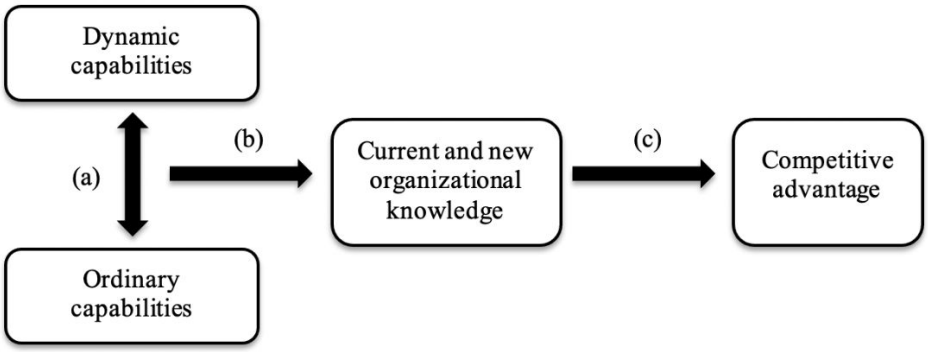
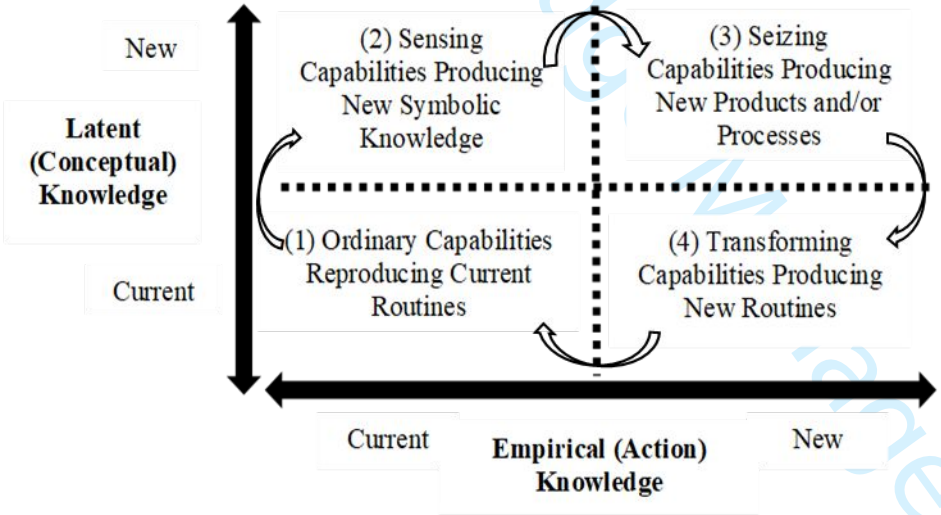
Annex: figures and tables.

Figure 1: Mechanisms connecting capabilities, organizational knowledge, and competitive advantages.



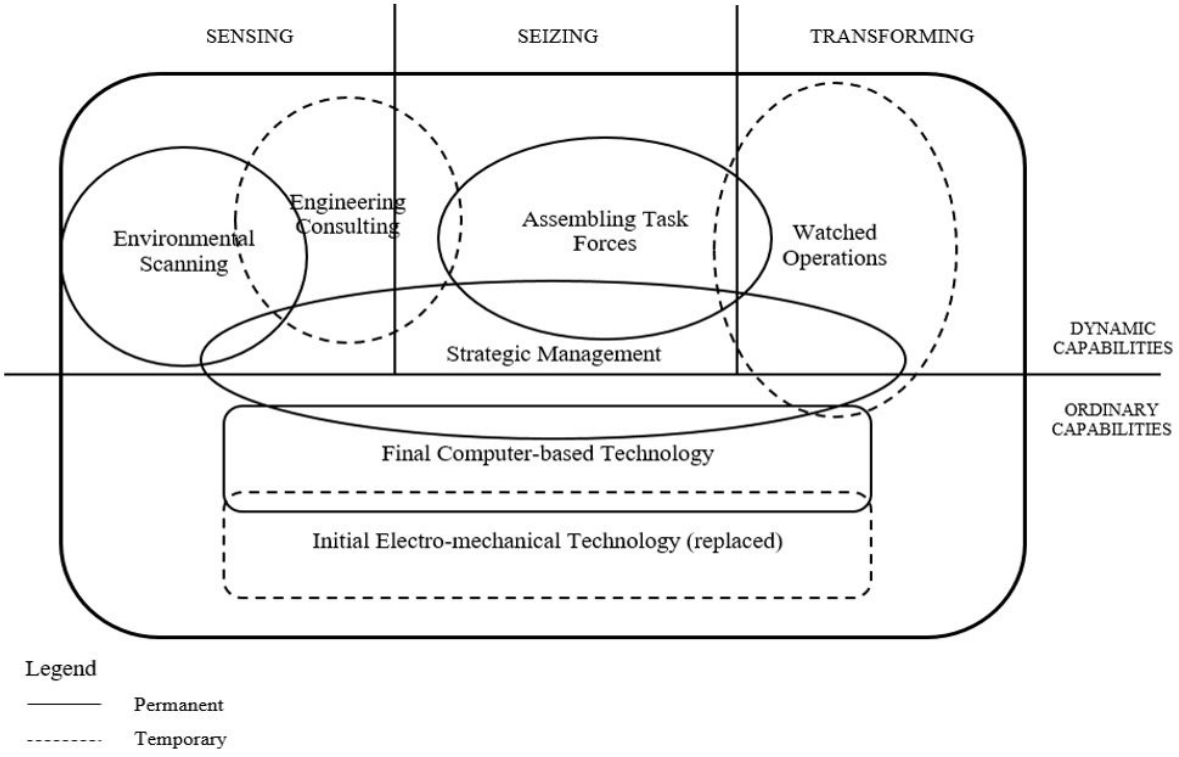
Source: Own elaboration.

Figure 2: Theoretical capabilities typological map.



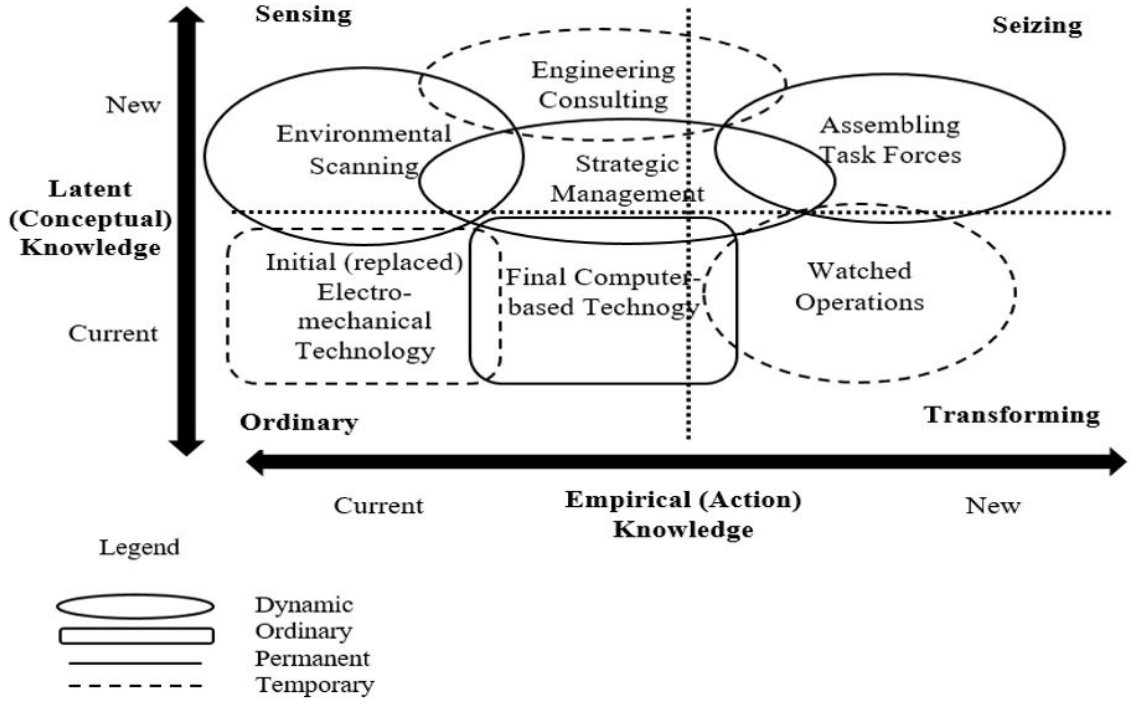
Source: Own elaboration.

Figure 3: Capabilities analyzed as categories in axial coding.



Source: Own elaboration.

Figure 4: Applied capabilities typological map.



Source: Own elaboration

Table 1. Interviewed Employees.

Director of Production
Sales Director
Industrial Manager
Agriculture Manager
Controller Manager
Environmental Manager (2)*
Energy Utilities Supervisor
R&D Supervisor
Automatization Supervisor
Energy Utilities Coordinator
Senior Agricultural Coordinator
Environmental Technologist
Energy Generation Operator
Carbon Market Director (Consultant)
Carbon Project Engineer (Consultant)
CDM (Government) Technical Advisor (GD)**
CDM (Government) Environmental Analyst 1
CDM (Government) Environmental Analyst 2

* *The Environmental Manager was interviewed twice*
** *The CDM Governmental Advisor and Analysts were interviewed during a group discussion (GD)*
Source: Own elaboration.

Table 2. Evidential excerpts and functional classifications of the dynamic capabilities in Energyplant from the analysis of four relevant interviews.

Dynamic Capabilities / **Interviewees**	Environmental Scanning	Strategic Management	Engineering Consulting	Assembling Task Forces	Watched Operations
Industrial Manager	6	7	7	3	2
Environmental Manager	6	3	11	5	2
Automatization Supervisor	4	7	9	7	4
Energy Utilities Coordinator	0	1	0	5	3
Total of Excerpts	**16**	**18**	**27**	**20**	**11**
Does the capability produce new conceptual knowledge while maintain previous empirical knowledge? (Sensing)	Yes	Yes	Yes	No	No
Does the capability produce both new conceptual and empirical knowledge? (Seizing)	No	Yes	No	Yes	No
Does the capability produce new empirical knowledge (routines) to achieve new conceptual knowledge previously developed? (Transforming)	No	Yes	No	Yes	Yes

Source: Own elaboration.