The orchestration of dynamic capabilities in cleantech companies

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Abstract

Purpose – The aim of this article is to present a model for the orchestration of dynamic capabilities (ODCs) in cleantech companies that aim to obtain competitive advantage in the market.
Design/methodology/approach – The authors present herein descriptive research guided by a qualitative multiple case study approach carried out with 12 cleantech companies.
Findings – The results have showed that the ODC model is present in the product/process cycle, thus providing new capabilities and generating sustainable competitive advantage through the research categories presented.
Research limitations/implications – This study contributes to the literature on the ODCs through microfoundations based on evidence of companies inserted in technological and intensively dynamic contexts.
Practical implications – This article demonstrates, through the ODC model, the main capabilities and characteristics of the assets of cleantech companies and how the process of renewing competencies to obtain competitive advantage occurs.
Originality/value – The ODC model utilizes technological resources in the product/process cycle. Asset specificity and the capacity for innovation allow cleantech companies to explore regulatory loopholes, making their sustainable model innovative and obtaining competitive advantage through the renewal of entrepreneurial capabilities and competencies.

Keywords Orchestration of dynamic capabilities, Cleantech, Dynamic capabilities
Paper type Research paper

1. Introduction

The management and allocation of resources and capabilities for a *sustainable competitive advantage* comes from the theoretical foundations of the resource-based view (RBV) (Barney, 1991; Barney, Wright, & Ketchen, 2001; Teece, Pisano, & Shuen, 1997). Sustainable competitive advantage is pursued by different types of companies and lies at the center of activity of organizations that seek to deliver market solutions with social and environmental character (Walsh & Dodds, 2017). Nevertheless, the dynamic allocation of resources and capabilities in companies and the constant search to achieve competitive advantage provided a new direction for strategy and innovation studies: through new digital technologies emerging in the market, environmental and social sustainability became a criterion and a

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niche for the performance of several types of organizations (Teece, Peteraf, & Leih, 2016; Walsh & Dodds, 2017).

In this context, early-stage companies and with scalable market models (startups) started to incorporate into their business model principles of environmental and social sustainability to compete in the market (Gaddy, Sivaram, Jones, & Wayman, 2017). This type of company deals with technology and digitalization to provide services and products that serve society, the environment and the economy through consumers that support the cause and benefit from the solutions addressed to the market (Cumming, Henriques, & Sadorsky, 2016). Startup companies with environmental and socioeconomic focus are known in the market as "cleantech companies" as they work with clean technologies to provide market solutions.

Cleantech companies have a high capacity to allocate resources, capabilities and competencies in environments of technological and regulatory uncertainty, thus operating based on environmental sustainability (Doblinger, Surana, & Anadon, 2019). Teece *et al.* (2016) mention Tesla as an example of startup company that can integrate its resources and create value through the orchestration of resources and capabilities. Even though the authors do not mention that this is the case of a successful "cleantech company," several other companies focused on clean technologies have been launched in the market to provide products focused on the environment and the society (Gaddy *et al.*, 2017; Cumming *et al.*, 2016).

Cleantech startups operate in sectors related to renewable energy, energy efficiency, energy trading, water consumption and waste, and even the simplest innovations that allow companies to operate their digital technologies to provide sustainability through products and services (Grubler & Wilson, 2014). This article assumes, based on previous research by Walsh and Dodds (2017), Teece and Linden (2017) and Teece (2018), that for these companies to enable environmentally sustainable business models (SBMs) and solutions, they need to achieve competitive advantage through the orchestration of dynamic capabilities (ODCs) and resources available in the market.

Based on this assumption, Feng *et al.* (2019) propose a framework that aims to better understand the dynamic capabilities involving startup companies. Feng *et al.* (2019) highlight the need to investigate ODC and resources in the startup context considering service provision and technological innovation sectors in different countries. Linde, Sjödin, Parida and Wincent (2021) present the orchestration in the context of smart cities and sustainable technologies, suggesting a few studies that show how such orchestration occurs in the entrepreneurial context, thus focusing on how technological, digital and service delivery solutions become a market differential. Complementarily, Teece (2018) affirms that understanding consumer needs can be resolved through the orchestration of technologies and organizational capabilities.

Based on the contextualization and research gaps presented by literature, the research question this paper aims to answer is as follows: "*How do companies orchestrate their dynamic capabilities to achieve competitive advantages in rapidly changing technological environments?*" To address such question, the aim of this article is to give evidence in the context of cleantech companies of how dynamic capabilities are orchestrated to propose an ODC model aimed at obtaining competitive advantage in the market.

Thus, the main thesis of this article – based on the existing literature and on the results found – is to validate the following research propositions: (1) the ODC happens in the product/process cycle of technology companies and (2) companies have technologies that enable ODC to gain competitive advantage. Consequently, the theoretical contribution of the present study complements literature on the ODCs through microfoundations based on evidence of cleantech companies inserted in technological and intensively dynamic contexts.

2. Theoretical framework

2.1 Dynamic capabilities and technology

The foundations of dynamic capabilities originate from the RBV (Teece & Linden, 2017). For resources and capabilities to achieve a sustainable competitive advantage, the RBV suggests that they must have four essential characteristics: they must be (1) valuable, (2) rare, (3) inimitable and (4) difficult to substitute (Barney, 1991; Barney *et al.*, 2001). These capabilities and resources can have an intangible character and manifest themselves in knowledge of individuals, processes and routines within each organization (Teece *et al.*, 1997).

Technological environments with a high degree of business transformation indicate that these resources, routines and entrepreneurial abilities need to adapt and transform due to the rapid change of business environments (Teece *et al.*, 2016). The *dynamic capabilities* can be defined as the company's processes that utilize resources to integrate, create and reconfigure internal and external competencies in environments of technological uncertainty (Teece *et al.*, 1997).

Technology and digitalization play an essential role for companies to allocate their resources and capabilities in a dynamic way (Kim & Lee, 2006). Figueiredo (2005) considers technology a capability that allows the adaptation of organizations through specific knowledge, which – when articulated – involve dimensions related to the abilities of individuals and companies to manage software, organizational routines in the digital environment, creation of new products and services, and even the tacit knowledge of individuals.

The abilities and knowledge accumulated and constantly being reconfigured to adapt to the market is an elementary attribute for the *dynamic capabilities* to provide economic benefits for companies (Luo, 2000). The capabilities are incorporated as companies articulate their resources to establish new strategies in order to create value and competitive advantage in the market. Considering the specificities of tangible and intangible assets of the company, it is management's responsibility to develop organizational processes to identify and seize opportunities (Teece *et al.*, 1997).

Teece *et al.* (2016) mention the companies Space X and Tesla as startups with high ability to allocate their *dynamic capabilities* to obtain competitive advantage from their technology positioning. The *dynamic capabilities* provide organizational agility so that companies can face the risks and uncertainty in an economy based on business models that require constant adaptation to react to market challenges (Teece & Linden, 2017). The dynamic capabilities and technology are concomitant themes that provide the necessary subsidies for organizations to orchestrate their resources, routines and processes (Teece & Linden, 2017). In parallel, Kim and Lee (2006) and Luo (2000) pave the way for technology and information sharing in a context of uncertainty and risks, making *dynamic capabilities* necessary for companies to obtain competitive advantage in local and global markets.

2.2 ODC and the resources of the company

The orchestration of resources and *dynamic capabilities* is rooted in the idea of positioning the company based on the strategy of resource allocation in a dynamic and innovative way to gain *competitive advantage* (Shuen & Sieber, 2009; Sirmon, Hitt, & Ireland, 2007). The ODCs involves the principles of sensing, seizing and reconfigure, which combined allow the company to orchestrate and recombine its own resources to adapt to the markets in which it operates (Teece & Linden, 2017; Ambrosini & Bowman, 2009).

In this article, we will use the definitions of sensing, seizing and reconfigure according to Teece *et al.* (2016), Teece and Linden (2017) and Shuen and Sieber (2009), as they were operationalized in a technological context like this article.

(1) *Sensing:* It refers to the ability of the company or the entrepreneur to identify technological opportunities and threats in existing markets. This concerns the

sensibility of the organization to recognize business opportunities through existing information and to create provisions for performance and technological development;

(2) *Seizing:* It refers to the mobilization of resources to anticipate the reaction of competitors and generate intellectual protection. Resource mobilization enables the refinement of business models through the allocation of resources to explore opportunities in the creation of new routines, processes and even products and services;

(3) *Reconfigure/Reconfiguring:* It relates to the ability of the company to change and transform its structure based on its objectives. The transformation of the company implies the creation of new routines and organizational processes, such as product innovation and quick strategic decision-making based on the available resources.

The principles of sensing, seizing and reconfigure are mechanisms for an organization to maintain itself in an environment of technological change and marked by consumer expectations (Teece *et al.*, 2016). Its orchestration allows the collaboration between companies and users to achieve new ways to innovate (Shuen & Sieber, 2009).

For the orchestration to occur, it is necessary to make use of resources in favor of dynamic capabilities. The evolution of the current capabilities and the creation of new ones to satisfy customers and serve markets depend on the orchestration of resources through a synchronized process that optimizes routines and processes and creates value for the organization (Sirmon *et al.*, 2007). This orchestration of resources combined with new technologies can make companies develop their dynamic capabilities, which consequently generate a competitive advantage in the digital contexts of organizations (Camillo, de Vasconcellos, & Amal, 2020).

Linde *et al.* (2021) explore the orchestration of resources from the perspective of innovation ecosystems and smart city technologies, thus suggesting a model in which sensing, seizing and reconfigure operate focused on the creation of new partnerships and alignments between innovative solutions and sustainable and environmental gains. The authors also explain that the articulation of existing resources allows cities to explore benefits from technological solutions, such as energy efficiency and water waste.

In the context of startup companies, Feng *et al.* (2019) present ODC as an essential element for an expansion strategy through low-cost technology. The principles of sensing, seizing and reconfigure provide technological capability for startup companies, thus allowing them to absorb external technologies and reconfigure their business model, spreading knowledge throughout the organization and leveraging competencies to explore their local market in a lean and dynamic approach.

The generation of SBM is multidimensional and complex. Therefore, there are only a few known success cases (Hart & Milstein, 2003). One of the main challenges found in the literature is to comprehend technological innovation, more specifically, its integration through the *ODCs* and companies at an early stage of technology development (e.g. cleantech companies, as cited by Evans *et al.*, 2017).

Based on the studies of Feng *et al.* (2019) and Linde *et al.* (2021), who approach ODC in the context of startup companies, the present article brings the seminal principles of sensing, seizing and reconfigure initially addressed by Teece *et al.* (2016), Teece and Linden (2017) and Teece *et al.* (1997) to investigate the context of cleantech companies.

2.3 Microfoundations and ODC

The microfoundations are based on the ability of managers/entrepreneurs to constantly orchestrate (identify, learn, coordinate and reconfigure) the opportunities that emerge from new technologies, consumer needs, market niches and competitors. Amongst the several

microfoundations, the managerial and cognitive dynamic capabilities of decision-makers are highlighted, whose performance is particularly necessary to achieve greater efficiency and organizational agility (Teece *et al.*, 2016). Through these capabilities, it is possible to create, distribute and capture value by exploring complementarities and managing co-specialization.

The microfoundations play a key role in the strategic articulation for taking advantage of entrepreneurial and technological resources and generating innovation through new capabilities that allow the reconfiguration of business models of different companies (Brink, 2019; Shuen, Feiler, & Teece, 2014).

2.4 Research propositions

2.4.1 The product/process cycle. The dynamic capabilities allow us to understand how companies innovate towards sustainability before growing legal pressures to develop sustainable products, services and production processes (Mousavi, Bossink, & van Vliet, 2018). The innovation that catalyzes sustainability makes companies rethink and reconfigure their products, processes, technologies and business models to find the rebalancing between capital and sustainable development (Evans *et al.*, 2017).

In dynamic capabilities, resources are learned, experimented and recombined to create products and processes, and transform already existing routines (Jiang, Chai, Shao, & Feng, 2018). To this end, according to Cumming *et al.* (2016), companies operate in a product/process cycle oriented towards technology. This cycle consists of four stages, and in the present study, we assume that the ODCs – involving the principles of sensing, seizing and reconfigure – is noted in these four stages of the product/process cycle.

According to Cumming *et al.* (2016), the first stage refers to technology research, in which companies look for gaps and opportunities in their respective markets to develop, and in the second stage, a technology that meets the needs of previous stage is found. Thus, sensing and seizing are noticed in the first two stages, respectively. In the third and fourth stages, reconfiguring is identified and refers to manufacturing and scale-up and roll-out, respectively. In the manufacturing and scale-up stage, already existing capabilities and competencies are used, thus reconfiguring the business model of the company. In the roll-out, processes are created and adapted to enable the solutions detected and outlined in the previous stages.

Conforming to such positioning, Sirmon *et al.* (2007) affirm that managers may need to orchestrate new resources and capabilities to create products and processes. Thus, companies can develop capabilities to meet market demands, which is concomitant with the four stages mentioned by Cumming *et al.* (2016).

According to such perspective, Proposition 1 is established based on ODC and considering all four stages of the product/process cycle.

Proposition 1. ODCs occur in the product/process cycle of technology companies.

2.4.2 Technology and the ODC model. Technology has been creating profitable opportunities for cleantech companies, especially for those involved with energy, waste and water treatment, with an emphasis on Internet of Things (IoT), in combination with data analytics, cloud computing and big data simulation (Jolly, Spodniak, & Raven, 2016). These are the existing technological resources that predominantly integrate the business model of cleantech companies (Giudici, Guerini, & Rossi-Lamastra, 2019).

Camillo *et al.* (2020) point out that the orchestration of resources together with the support of new technologies can make companies develop their digital and technological capabilities, gaining competitive advantage. This process is developed through the operation of technological resources in order to automate processes, assist in new complementary ways of conducting business and enabling new disruptive ways of conducting business. By combining the architecture and refinement of business models, digital technologies can exert

a positive influence on the creation and delivery of value and on cost reduction, thus ensuring these competitive advantages in a sustainable way (Mousavi *et al.*, 2018; Jiang *et al.*, 2018).

When considering the technological resources operationalized by companies in a context of constant transformation, cleantech companies have their own unique way, i.e. different from conventional companies, of orchestrating technological resources and dynamic capabilities to generate competitive advantage (Proposition 2).

Proposition 2. Companies have technologies that enable ODC to gain competitive advantage.

2.4.3 Theoretical model of the propositions. The propositions established support the research question and contribute to the fulfillment of the aim of this paper, which is to present an ODC model for cleantech companies aiming to obtain competitive advantage in the market. Propositions are tools that collaborate with the explanation of the ODC model in the particular case of cleantech companies and can be visualized in Figure 1, which presents the theoretical model of the propositions of this research.

3. Methodology of the research

3.1 Method

The qualitative and exploratory approach was chosen to carry out this research, and the multiple case study was the chosen design to achieve the research goals. Case study is an empirical investigation that seeks to understand a contemporary phenomenon within its context considering the events in the practical universe, especially when the limits between the phenomenon and the context are not explicitly defined (Yin, 2009). Studies by Yin (2009) and Eisenhardt (1989) emphasize that such a methodological approach is appropriate and indicated to answer research questions that address *"how"* the phenomena under investigation occur.

3.2 Context of the research: description of the cleantech companies

Companies that use clean technology are those with technologies oriented towards the production and commercialization of products, services or processes that add value based on the utilization of clean and renewable resources (Giudici *et al.*, 2019). These companies are known as cleantech and aim to offer innovations through technology to meet environmental and socioeconomic needs. Thus, cleantech companies make use of market solutions to address issues such as recycling, efficient energy use, access to renewable energy, utilization of electric vehicles, reporting on carbon emissions, water conservation and even fighting poverty through technological monitoring systems (Cumming *et al.*, 2016).

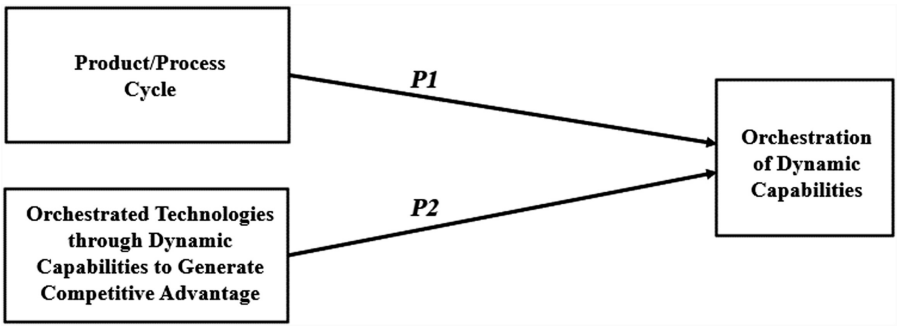


Figure 1.
Theoretical model of the propostions

3.3 Case selection

Feng *et al.* (2019) affirm that understanding startups' case studies and their technological contexts may bring relevant contributions to the field of dynamic capabilities, while Ambrosini and Bowman (2009), Teece and Linden (2017) and Teece *et al.* (2016) ratify the importance of carrying out case studies on startup companies and orchestration of capabilities in economy sectors that demand an agile transformation and reconfiguration of the companies' business model to obtain competitive advantage.

Based on such assumptions, the case study method is employed to better understand startup companies in the context of cleantechs. Three predominant criteria were selected for the delimitation of the case selection: *(1) the company must be cleantech*; *(2) sector/industry in which the company operates* and *(3) digital technology utilized by cleantechs*.

3.4 Data collection

Shuen *et al.* (2014) argue that dynamic capabilities reside, in part, in managers and in the top management team. Therefore, in important moments, the ability of the chief executive officer (CEO) and management in general would be enough to recognize development or a trend, thus subsequently delineating a response while orienting the company in co-creation and co-development activities – this can be the most relevant element of the company's dynamic capabilities. Based on these assumptions, Table 1 presents the sample description of this research. The interviews were collected up to the point of data saturation indicated by the MaxQda software.

For the selection of companies, we used the study entitled Mapping of the Brazilian Cleantech Startup Ecosystem (FGV, 2019). Such mapping was accomplished to better understand the ecosystem of startup companies operating in the segment of clean technology. We have also verified the self-declared cleantech startups in the Distrito database, i.e. an innovation platform for startup companies, corporations and investors. We have also utilized the platform Liga Ventures, which connects cleantech startup companies to large companies to make business.

The data selected for analysis were collected and triangulated from three main sources: (1) semi-structured interviews, (2) observation and field notes and (3) documents and websites from the energy sector and the organizations selected for analysis.

4. Data and content analysis

The analysis technique used for this study was the content analysis, which was supported by the MaxQda software in addition to the full reading of the articles analyzed (Bardin, 2016). The procedure adopted to compose the process of content analysis was as follows: (1) data organization; (2) search for items with incidence of repetition; (3) creation of sets of items (deductive and inductive categories); (4) creation of analysis patterns and (5) creation of tables, visual models and figures to comprehend the categories and subcategories with software support.

Table 2 presents the representative transcriptions based on the repetition of categories identified in the software as preponderant when observing the foundations of the theoretical framework utilized. The inductive categories are the categories that have been induced by the theoretical framework. The deductive categories, in turn, are emerging categories that came up during the data analysis of the software and symbolize the research findings presented in the section for results and discussion.

5. Results and discussion

Table 2 shows that the microfoundations are being operated by entrepreneurs so that cleantech companies use their technological resources to identify threats and reconfigure

their business model using technologies such as artificial intelligence, IoT and Big Data, thus proposing business models that adapt to the demands of consumers who seek more efficiency and less energy use. The business transformation proved to be relevant in this interview round and is directly related to the company's ability to create autonomous processes, providing ways to validate the product cycle (Cumming *et al.*, 2016).

The samples agree with literature and reiterate that ODC-oriented companies create and reconfigure their managerial and organizational routines, taking advantage of opportunities and generating innovation while pursuing evolutionary fitness (Mousavi *et al.*, 2018). Innovations in clean energy products and processes consider energy costs or resources when looking for opportunities to develop solutions that bring competitive advantage, preferably with pioneering spirit. Thus, the company perceives a better combination between environmental and financial performance (Jiang *et al.*, 2018).

Technological resources are critical for the implementation of social and environmental solutions that provide consumers with market benefits. When these resources are orchestrated, new market solutions are implemented by the company, leading to innovations that explore regulatory loopholes in the market (Doblinger *et al.*, 2019). The sensing and seizing categories are presented in the technology research and development stages, while the reconfiguring category is to be found in the stages of manufacturing and scale-up and roll-out.

When orchestrating dynamic capabilities in the product cycle, the technological resources are the protagonists, renewing technological competencies to implement solutions adapted to energy markets, renewable energy and recycling. These competencies provide cleantech companies with asset specificities, which enable them to take advantage of market and regulatory gaps. For cleantech companies to operate technological models through their resources, they need assets operating on the reconfiguring microfoundation to deliver a solution, as reported by the interviewees *E1* and *E3*. *Asset specificity*[3] is a fundamental factor to provide a cleantech company with competitive advantage in relation to other categories of companies.

In the present research, *asset specificity* emerged as a fundamental factor because it addresses socioenvironmental issues through technologies that are used as resources in the product cycle, providing capabilities for companies to carry out other innovations (Teece *et al.*, 1997; Giudici *et al.*, 2019). Asset specificity subsidized alternative governance formats that, when providing new innovative capabilities, allow the structuring of a sustainable business model, which is difficult to replicate by competitors (FGV, 2019; Gaddy *et al.*, 2017).

The *innovation capability* is the result of the renewal of competencies through the ODCs and technological resources that are present in the product cycle of cleantech companies. In these companies, the *innovation capability* manifests itself as a set of organizational practices to develop new products and processes (Cumming *et al.*, 2016). Such capability allows the constant reconfiguration of the cleantech company, providing other new capabilities that enable a strategic direction of technology to manage projects and modify the organizational structure of the company, thus meeting market changes. The *innovation capability* in this type of company operates on the organization's knowledge and provides means for entrepreneurs to explore market opportunities not yet regulated by the industrial sectors through new ways of offering products, such as renewable energy compensation, certification mechanisms and transactions in virtual networks.

The *capability to explore regulatory loopholes* stems from the ability to innovate and is directly related to asset specificity. The interviewees reported that changing regulations and the in-depth knowledge of legal mechanisms allow entrepreneurs to establish formal contracts to enable the business model and the orchestrated technological resources (FGV, 2019; Giudici *et al.*, 2019). In this study, the capability to explore regulatory loopholes emerged mainly as the ability to perform adapted contracts to meet the specific demands of consumers

seeking to reduce water consumption, energy use and gas emissions. The sectoral knowledge of the entrepreneurs is fundamental to elaborate the business model, even if the company already has the available technological resources (Gaddy *et al.*, 2017). Contractual arrangements about the sectorial knowledge of the entrepreneur allow the development of the capability to explore regulatory loopholes in the sector and to address sustainable solutions.

The emerging categories of *innovation capability*, *asset specificity* and the *capability to explore regulatory loopholes and* unfold into two main outcomes of the ODC process: *sustainable business model innovation* and *sustainable competitive advantage*.

Considering the findings on *sustainable business model innovation*, the cleantech cases investigated herein showed that the business models are sustainable due to the orchestration of technical resources that allow the exploration of socioenvironmental benefits in market solutions (Teece, 2018; Teece & Linden, 2017). In this case, the market innovation capability implemented allows business models to be unique and specific, thus providing distinct ways to explore regulatory gaps in the market. These solutions utilize technological resources in order to save water, make energy processes more efficient, trade renewable energy and even reduce carbon emissions in the atmosphere, thus ratifying the sustainable, social and environmental nature of cleantech companies. The microfoundations operate constantly so that this business model remains functioning and can renew the capabilities of this sort of company. In this sense, the alignment of theoretical foundations of the product cycle and ODC provides contributions to the research field, highlighting specific business models based on dynamic innovation capabilities (Teece *et al.*, 2016; Walsh & Dodds, 2017).

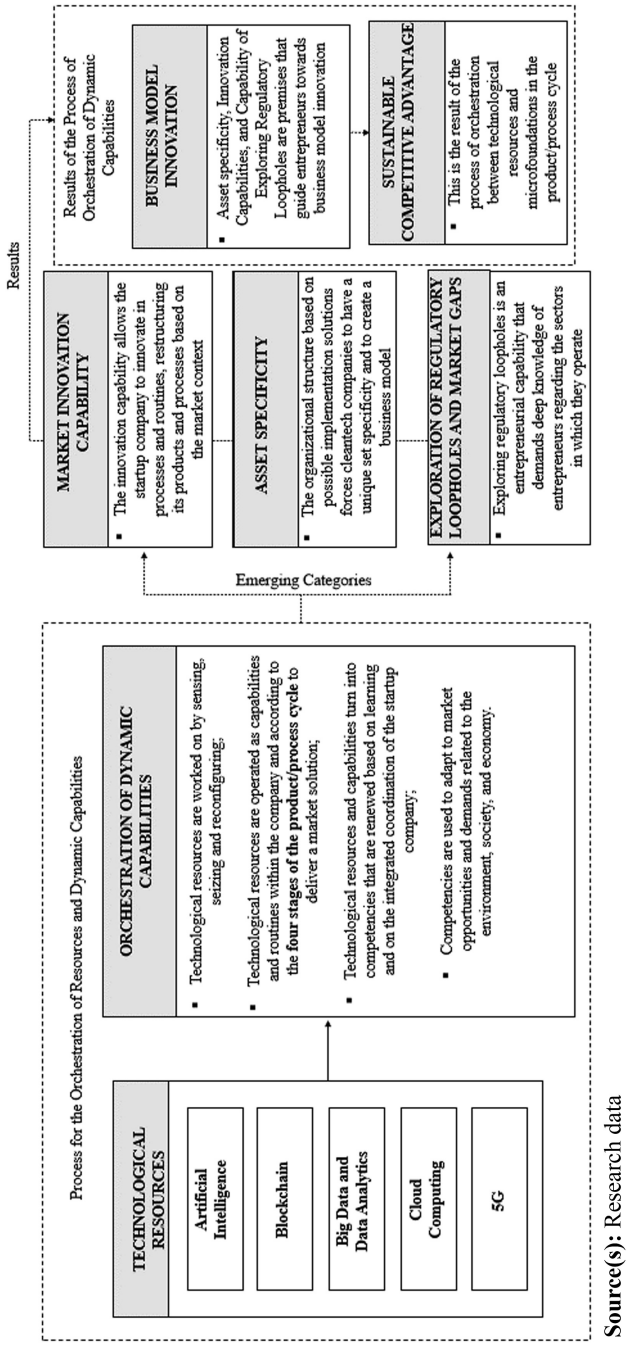
The business model is a catalyst source for value creation through the exploration of business opportunities, as Teece (2018) and Feng *et al.* (2019) pointed out considering the e-business scenario. Innovation is anchored in technology and asset specificity, which leads to the development of new combinations of resources to create value and contribute to the generation of competitive advantage, thus supporting the findings presented in the literature review (Teece, 2018; Linde *et al.*, 2021; Brink, 2019; Feng *et al.*, 2019).

Sustainable competitive advantage is the result of a business model stemming from ODC and technological resources of cleantech companies. These models are difficult to replicate as they trace the strategic positioning, supporting the mobilization of technological assets. In this study, the competitive advantage of the cleantech companies is the result of an alignment model between the product/process technological cycle and ODC (Cumming *et al.*, 2016).

While this work identifies the qualitative categories that complement the theoretical foundations and literature, emerging categories not yet explored by recent literature on technology companies came up, contradicting recent studies (Cumming *et al.*, 2016; Mousavi *et al.*, 2018; Jiang *et al.*, 2018). These emerging categories manifest in the present research as the ability to explore regulatory loopholes, innovation capability and asset specificity.

Propositions 1 and 2 were supported in our study, ratifying that the microfoundations orchestrate the technological resources of cleantech companies within their product/process cycle. At first, aiming to increase investments and create value to become more financially attractive, cleantech companies evaluate and seek new technologies, opportunities and regulatory loopholes. Based on these findings, the development of these technologies begins, allocating resources to – third – reconfigure their routines and business model to enable the large-scale manufacturing of the products resulting from these opportunities. Finally, this reconfiguration is improved through the implementation of solutions.

Based on the interviews carried out in the cleantech context and the analysis of the deductive and inductive categories, it is possible to synthetize the ODC process into single model (Figure 2). It is noteworthy that the technological resources transform through the emerging categories to generate business model innovation and sustainable competitive advantage.



Source(s): Research data

Figure 2.
ODC model of a cleantech company

6. Final considerations

The two propositions of this article were supported, thus pointing out that ODC presents itself in the product/process cycle of companies and that technologies enable the ODC to gain competitive advantage, meeting the aim of the research.

The model presented brings a theoretical contribution to ODC through the application of technological resources in the product/process cycle of cleantech companies. Furthermore, asset specificity and innovation capability allow this type of company to explore regulatory loopholes, making its sustainable business model innovative and seizing competitive advantage through the renewal of entrepreneurial capabilities and competencies, thus filling the gaps pointed out by Teece (2018), Linde *et al.* (2021), Brink (2019) and Feng *et al.* (2019). The practical contribution of this study highlights the main capabilities and characteristics of cleantech companies' assets, which collaborate with the systematization and adaptation process of these companies in the startup market. Additionally, the strategic positioning of cleantech companies to gain competitive advantage depends on the ability of entrepreneurs to articulate their capabilities to explore regulatory loopholes and generate sustainable innovations for the consumer.

The differential presented herein concerning the theoretical contributions is the comprehension of the orchestration of technology and organizational capabilities in scenarios marked by constant and accelerated transformation. Therefore, this article aims to meet the lack of exploration of ODC in the context of startup companies focused on technological, digital and service solutions (Teece, 2018; Linde *et al.*, 2021; Feng *et al.*, 2019).

For future research, we suggest researchers to focus on the role of emerging categories in the business model of cleantech companies considering an expansion in the research sample and utilizing quantitative techniques to understand the structural relations indicated by the research field.

Notes

(1) Table 1 contains a description of the sample and is attached in the Supplementary documents of this article.

(2) Table 2 contains the qualitative reports and the repetition of categories extracted from interviews carried out with cleantech and can be found in the Supplementary documents of this article.

(3) The concept of asset specificity is based on the foundations of dynamic capabilities; it refers to integrated resources that encompass assets, individuals and groups in order to enable the accomplishment of distinct activities (Teece *et al.*, 1997). Asset specificity definition extends to assets traded for single use without sacrificing productive value, considering specific characteristics related to locational, temporal, human and governance resources. In the present article, asset specificity is considered an emerging category that reduces the transactional costs of operations due to the characteristics and resources of the cleantech companies.

References

Ambrosini, V., & Bowman, C. (2009). What are dynamic capabilities and are they a useful construct in strategic management? *International Journal of Management Reviews*, *11*(1), 29–49. doi: 10.1111/j.1468-2370.2008.00251.x

Bardin, L. (2016). *Análise de Conteúdo* (p. 70). São Paulo: Edições.

Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of Management*, *17*(1), 99–120. doi: 10.1177/014920639101700108

Barney, J., Wright, M., & Ketchen, D. J. Jr (2001). The resource-based view of the firm: Ten years after 1991. *Journal of Management*, *27*(6), 625–641. doi: 10.1177/014920630102700601

Brink, T. (2019). Orchestration of dynamic capabilities for competitive advantage. *International Journal of Energy Sector Management*, *13*(4). doi:10.1108/IJESM-09-2018-0005.

Camillo, G. M., de Vasconcellos, S. L., & Amal, M. (2020). Capacidades Digitais: Uma revisão bibliométrica. *Future Studies Research Journal: Trends and Strategies*, *12*(3). doi: 10.24023/FutureJournal/2175-5825/2020.v12i3.551

Cumming, D., Henriques, I., & Sadorsky, P. (2016). "Cleantech" venture capital around the world. *International Review of Financial Analysis*, *44*, 86–97. doi: 10.1016/j.irfa.2016.01.015

Doblinger, C., Surana, K., & Anadon, L. D. (2019). Governments as partners: The role of alliances in US cleantech startup innovation. *Research Policy*, *48*(6), 1458–1475. doi: 10.1016/j.respol.2019.02.006

Eisenhardt, K. M. (1989). Building theories from case study research. *Academy of Management Review*, *14*(4), 532–550. doi: 10.2307/258557

Evans, S., Vladimirova, D., Holgado, M., Van Fossen, K., Yang, M., Silva, E. A., & Barlow, C. Y. (2017). Business model innovation for sustainability: Towards a unified perspective for creation of sustainable business models. *Business Strategy and the Environment*, *26*(5), 597–608. doi: 10.1002/bse.1939

Feng, N., Fu, C., Wei, F., Peng, Z., Zhang, Q., & Zhang, K. H. (2019). The key role of dynamic capabilities in the evolutionary process for a startup to develop into an innovation ecosystem leader: An indepth case study. *Journal of Engineering and Technology Management*, *54*, 81–96. doi: 10.1016/j.jengtecman.2019.11.002

FGV-Fundação Getúlio, Vargas. (2019). *Centro de Estudos em Sustentabilidade. Mapeamento do Ecossistema de Startups Cleantechs no Brasil*. São Paulo: FGV EAESP - GVces - Relatórios Técnicos [Acesso em 19 de março de 2021].

Figueiredo, P. N. (2005). Acumulação tecnológica e inovação industrial: conceitos, mensuração e evidências no Brasil. *São Paulo Em Perspectiva*, *19*(1), 54–69. doi: 10.1590/S0102-88392005000100005

Gaddy, B. E., Sivaram, V., Jones, T. B., & Wayman, L. (2017). Venture capital and cleantech: The wrong model for energy innovation. *Energy Policy*, *102*, 385–395. doi: 10.1016/j.enpol.2016.12.035

Giudici, G., Guerini, M., & Rossi-Lamastra, C. (2019). The creation of cleantech startups at the local level: The role of knowledge availability and environmental awareness. *Small Business Economics*, *52*(4), 815–830. doi: 10.1007/s11187-017-9936-9

Grubler, A., & Wilson, C. (2014). The energy technology innovation. In Grubler, A., & Wilson, C. (Eds.), *Energy technology innovation: Learning from historical successes and failures*. Cambridge University Press (in press).

Hart, S. L., & Milstein, M. B. (2003). Creating sustainable value. *Academy of Management Executive*, *17*(2), 56–67. doi: 10.5465/ame.2003.10025194

Jiang, W., Chai, H., Shao, J., & Feng, T. (2018). Green entrepreneurial orientation for enhancing firm performance: A dynamic capability perspective. *Journal of Cleaner Production*, *198*, 1311–1323. doi: 10.1016/j.jclepro.2018.07.104

Jolly, S., Spodniak, P., & Raven, R. P. J. M. (2016). Institutional entrepreneurship in transforming energy systems towards sustainability: Wind energy in Finland and India. *Energy Research and Social Science*, *17*, 102–118. doi: 10.1016/j.erss.2016.04.002

Kim, S., & Lee, H. (2006). The impact of organizational context and information technology on employee knowledge-sharing capabilities. *Public Administration Review*, *66*(3), 370–385. doi: 10.1111/j.1540-6210.2006.00595.x

Linde, L., Sjödin, D., Parida, V., & Wincent, J. (2021). Dynamic capabilities for ecosystem orchestration a capability-based framework for smart city innovation initiatives. *Technological Forecasting and Social Change*, *166*, 120614. doi: 10.1016/j.techfore.2021.120614

Luo, Y. (2000). Dynamic capabilities in international expansion. *Journal of World Business*, *35*(4), 355–378. doi: 10.1016/S1090-9516(00)00043-2

Mousavi, S., Bossink, B., & van Vliet, M. (2018). Dynamic capabilities and organizational routines for managing innovation towards sustainability. *Journal of Cleaner Production*, *203*, 224–239. doi: 10.1016/j.jclepro.2018.08.215

Shuen, A., Feiler, P. F., & Teece, D. J. (2014). Dynamic capabilities in the upstream oil and gas sector: Managing next generation competition. *Energy Strategy Reviews*, *3*, 5–13. doi: 10.1016/j.esr.2014.05.002

Shuen, A., & Sieber, S. (2009). Orchestrating the new dynamic capabilities. *IESE Insights*, (3), 58–65, Fourth Quarter. doi: 10.15581/002.ART-1605

Sirmon, D. G., Hitt, M. A., & Ireland, R. D. (2007). Managing firm resources in dynamic environments to create value: Looking inside the black box. *Academy of Management Review*, *32*(1), 273–292. doi: 10.5465/amr.2007.23466005

Teece, D. J. (2018). Business models and dynamic capabilities. *Long Range Planning*, *51*(1), 40–49. doi: 10.1016/j.lrp.2017.06.007

Teece, D. J., & Linden, G. (2017). Business models, value capture, and the digital enterprise. *Journal of Organization Design*, *6*(1), 1–14. doi: 10.1186/s41469-017-0018-x

Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal*, *18*(7), 509–533. doi: 10.1002/(SICI)1097-0266(199708)18:73.0.CO;2-Z

Teece, D., Peteraf, M., & Leih, S. (2016). Dynamic capabilities and organizational agility: Risk, uncertainty, and strategy in the innovation economy. *California Management Review*, *58*(4), 13–35. doi: 10.1525/cmr.2016.58.4.13

Walsh, P. R., & Dodds, R. (2017). Measuring the choice of environmental sustainability strategies in creating a competitive advantage. *Business Strategy and the Environment*, *26*(5), 672–687. doi: 10.1002/bse.1949

Yin, R. K. (2009). How to do better case studies. In *The SAGE Handbook of Applied Social Research Methods* (Vol. 2, pp. 254–282). doi: 10.4135/9781483348858.n8

Further reading

Bocken, N. M., & Geradts, T. H. (2020). Barriers and drivers to sustainable business model innovation: Organization design and dynamic capabilities. *Long Range Planning*, *53*(4), 101950. doi: 10.1016/j.lrp.2019.101950

Appendix

Supplementary details are available in online for this article.

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