

Dynamic capabilities in the open innovation process of agricultural research: the case of Embrapa Fisheries and Aquaculture

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ABSTRACT

This study aims to analyze the dynamic capabilities (DCs) involved in the open innovation process of Embrapa Fisheries and Aquaculture (EFA). The article sought to identify the microfoundations of the DCs involved in EFA routines, the required open innovation capabilities, and the cognitive biases that interfere with the identified DCs. The methodology used was document analysis, semi-structured interviews, and content analysis using the NVIVO qualitative research software. Fourteen people with a management function at EFA were interviewed. Results show that the EFA made efforts to adjust its processes to the OI logic by defining the target segments and partner profiles. The identified OI capabilities were business, prospecting, incorporation of changes, improvement of internal processes, and agility in meeting demands. Finally, the identified cognitive biases were the not invented here syndrome (NIHS), the risk aversion, the endowment effect, and the short-term view.

KEYWORDS | DYNAMIC CAPABILITIES; OPEN INNOVATION; OPEN INNOVATION CAPABILITIES; COGNITIVE BIASES

1. Introduction

Dynamic capabilities (DCs) and open innovation (OI) are closely related concepts. When they are well understood and applied, they give companies and institutions a differentiated position in a dynamic and competitive market. Both areas are contemporary, with the concept of DCs proposed by Teece, Pisano and Shuen (1997) and OI by Chesbrough (2003). Bogers et al. (2019) considers that DCs can contribute substantially to the OI process, mainly in promoting interaction between the company's internal resources and the external resources of the industry value chain. Even with this great potential, Teece (2020) asserts that few studies seek the comprehension of DCs' impacts on OI within the scope of a company's strategic management. Therefore, studying the interaction of these areas is relevant to guarantee the sustainable development of an organization.

Since 2018, the Brazilian Agricultural Research Corporation¹ (Embrapa) has outlined the incorporation of the open innovation process as a guideline (EMPRESA BRASILEIRA DE PESQUISA AGROPECUÁRIA, 2023a). In this way, all its 43 Embrapa research centers have been committed to updating, adapting its processes, and operationalizing the OI management, including the Embrapa Fisheries and Aquaculture (EFA), located in Palmas, Tocantins state. The EFA was created in 2009 and it was assigned the mission of "developing technologies and knowledge regarding the entire aquaculture production chain" in Brazil (EMPRESA BRASILEIRA DE PESQUISA AGROPECUÁRIA, 2023b). The species researched by this department involve native fish such as pirarucu, tambaqui, surubins and exotic species such as tilapia.

Therefore, understanding how the OI process has been developed at EFA is of utmost importance to guide the strategic management of

¹ The Brazilian Agricultural Research Corporation (Embrapa) is a public company created by the Ministry of Agriculture, Livestock and Supply (MAPA), in 1973, to develop a technological base for a genuinely tropical agriculture and livestock model. The company is committed to guaranteeing Brazil's food security and ensuring a prominent position for this country in the international food, fiber, and energy market.

research companies, whether to repair actions already proposed and ongoing, or to propose and assimilate new demands arising from the production sector. As the EFA did not use to privilege and prioritize OI actions in its internal guidelines, many changes were required to make interaction between a public company and the private sector possible. Therefore, the more clarity regarding the changes necessary to interact with the market, the greater the chances of serving it more efficiently. Given this context, the following research problem arose: how can the application of the microfoundations of dynamic capabilities contribute to the development of open innovation at Embrapa Fisheries and Aquaculture? Microfoundations of DCs are understood as the way in which an organization's routines and processes are structured within the scope of their respective foundations (FROEHLICH; BITENCOURT; BOSSLE, 2017).

To answer this research problem, the general objective was to “analyse the dynamic capabilities involved in the open innovation process in the agricultural research sector, based on the case study of Embrapa Fisheries and Aquaculture (EFA), aiming to support the improvement of strategic management”. Deepening the understanding of the necessary DCs for the agricultural research sector allows for a broader understanding of the DCs microfoundations action in the OI process. Thus, in addition to understanding the exogenous aspects inherent to OI, this study aims to understand the processes that need to be organized and/or restructured internally in an organization to enable the adequate implementation of OI (endogenous aspects).

As specific objectives, we sought to: (I) identify the microfoundations of the dynamic capabilities involved in the work routines established at EFA; (II) identify the open innovation capabilities required at the EFA and (III) analyse the cognitive biases that interfere with the identified dynamic capabilities and the EFA's OI process. The methodology used to achieve the aim was qualitative research using a case study. To collect sources of evidence, 14 interviews were carried out with individuals in management positions at EFA and documentary analysis of regulations and other sources related to the innovation process.

The number of interviewees was determined using the theoretical saturation technique (NASCIMENTO et al., 2018). Bardin's (2011) content analysis was used to analyse the interviews, using the NVIVO qualitative data analysis software.

The theoretical contribution of the article consists on carrying out a broad analysis of the problem studied with the combination of three important theoretical currents, namely: dynamic capabilities and their microfoundations, open innovation and behavioural economics. This allowed have a more in-depth understanding of the object of study from different perspectives. It is worth highlighting that carrying out the study in a public company (with peculiarities related to its structure and legal regime) is another distinctive element of this research. Considering that, in general, studies are carried out in private companies, which are relatively less subject to constraints administrative and legal aspects than those supervised by the government.

Regarding empirical contributions, the results found in the research can support the management in making strategic decisions related to the improvement of open innovation process, as well as in the development of the dynamic capabilities necessary for dialogue between internal knowledge of the company, with the knowledge and demands of the value chain. The possibility of replicating this study in other companies, either public or private, is also important, seeking to expand the understanding of the open innovation process.

2. Dynamic capabilities as a mechanism to help the development of open innovation: foundations and microfoundations

The concept of dynamic capabilities was initially proposed in the famous article published by Teece, Pisano and Shuen (1997), Dynamic capabilities and strategic management:

[...] the firm's ability to integrate, build and reconfigure internal and external competences to adress rapidly changing environments.

Dynamic capabilities thus reflect an organization's ability to achieve new and innovative forms of competitive advantage given path dependencies and market positions (TEECE; PISANO; SHUEN, 1997, p. 516).

The authors consider that DCs are relevant in organizations that operate in highly dynamic environments (FROEHLICH; BITENCOURT; BOSSLE, 2017; ARO; PEREZ, 2021). Within the scope of management, DCs can contribute to generating a market advantage for the company, making it more profitable and competitive. In this regard, Teece (2020) states that the theory of dynamic capabilities used theories of evolutionary economics and theories of strategic management of the firm to answer how firms can build and maintain competitive advantage in an extremely dynamic and competitive market.

Teece (2020) refined the concept of dynamic capabilities over time. For the author, DCs are divided into 3 foundations: capabilities to sense the context of the environment (sensing), capabilities to take advantage of opportunities (seizing), and capabilities to manage threats and transformations (transforming). Each foundation represents a set of processes, skills and structure that will serve as the basis for creating dynamic capabilities (DOBELIN; GALINA, 2019).

Froehlich, Bitencourt and Bossle (2017) state that each of these foundations is composed of microfoundations that can be understood as routines and structuring processes of their respective foundations, as can be seen in Table 1 below.

The foundation of sensing is related to the ability to prospect, scan and search for opportunities in different markets and different technologies that involves the evolution of a sector or the diversification of markets (SANCHEZ et al., 2022). Dobelin and Galina (2019) consider that through the foundation of sensing it is possible to obtain information and knowledge with the potential to be converted into new opportunities, and look for ranges of new segments to be explored to take advantage of them as soon as they become feasible (TEECE, 2007).

The foundation of seizing, according to Teece (2007), implies the maintenance and improvement of the organization's technological assets

TABLE 1
Foundations and microfoundations of DCs

Foundation	Microfoundations	Definitions
Sensing	Processes for directing internal Research and Development (RD) work.	New ideas, opportunities, and niches for developing RD actions.
	Suppliers' exploration process to complement the organization's innovations.	Prospecting partners to work on codeveloping the company's innovation actions.
	Processes to explore exogenous scientific and technological developments.	Prospecting existing technologies on the market that may be useful to build up technologies developed internally in the company.
	Processes to identify target market segments and innovation.	Monitoring and filtering internal and external information and knowledge of technologies and markets that can be explored.
Seizing	Customer solutions and business models.	Features that must be introduced into the product or service.
	Selection of organizational boundaries.	Define the scope of the organization's activities and boundaries.
	Routines for selecting decision-making protocols.	When faced with an opportunity, what actions should be taken to take advantage of it.
	Routines to build commitment loyalty.	Familiarity and commitment of people with the proposed organizational changes.
Transforming	Decentralization and decomposition.	Flexibility of relationships and decentralization of decision-making.
	Coespecialization	Development of technological products complementary to existing ones (diversification of assets)
	Governance and knowledge management.	Routines for integrating external know-how, learning, and knowledge integration (integrating internal and external knowledge of the firm).

Source: Adapted from Teece (2007).

and competencies tracked and learned in the sensing foundation. In this way, we seek to mature these technologies so that, at an opportune time, we can invest heavily in planning and strategies for their insertion and positioning in the market (ZAHRA; LIU; SI, 2023). It is, therefore, a response from the organization to the dynamic and competitive environment in which it operates (DOBELIN; GALINA, 2019).

Finally, the transforming foundation is related to the reconfiguration of organizational culture aiming to accommodate profound internal changes (DOBELIN; GALINA, 2019). In general, the foundation

sensing is carried out in a similar way by different companies and the foundation seizing and transforming are those that in fact confer competitive advantage to organizations (BOGERS et al., 2019; ZAHRA; LIU; SI, 2023). Teece (2020) states that one of the ways to develop a company's dynamic capabilities is the development of an open innovation process as it provides learning about new technological opportunities and allows the capture of resources that can be used to improve DCs.

2.1 Dynamic capability as a catalyst for the open innovation process

Chesbrough and Crowther (2006) highlight that the OI process can basically be adopted in two different ways: inbound or outbound. Inbound OI occurs when knowledge and technologies from external sources are incorporated to stimulate the internal innovative process of firms (CHESBROUGH; CROWTHER, 2006; MAZZOLA; BRUCCOLERI; PERRONE, 2012; MOURA et al., 2019). On the other hand, outbound OI occurs when knowledge and technologies are transferred to other firms and can be easily exemplified through the sale of patents, licensing of technologies and creation of spin-offs (CHESBROUGH; CROWTHER, 2006; FERRARI; SCALIZA; JUGEND, 2019). Bogers et al. (2019) consider that OI processes, whether inbound or outbound, contribute strongly to the development of the DCs of innovative companies.

The development of open innovation is possible through the company's opening to external knowledge and technologies. In this way, dynamic capabilities play an essential role in promoting interaction between internal and external resources (MOURA et al., 2019). Thus, Ferrari, Scaliza and Jugend (2019) highlight that OI has been used to intensify the flow of knowledge arising from research and development internally - produced by the research institution itself - and externally - resulting from cooperation with the productive sector.

In this regard, Bogers et al. (2019) consider that dynamic capabilities help to optimize the open innovation process in companies. In this context, Teece (2020) states that strong DCs contribute to

increasing the effectiveness of OI. The foundations “sensing, seizing and transforming” help companies to enjoy the benefits arising from OI (BOGERS et al., 2019).

Regarding the relationship between open innovation and dynamic capabilities, Teece (2020) states the following:

Open innovation and dynamic capabilities have a lot in common. They are both quite general and require contextual specifications. They have organizational as well as managerial implications; and they can be applied at the business unit, enterprise, or ecosystem level. But there are also critical differences. While open innovation is essentially a set of processes, the dynamic capabilities framework is a systemic theory of strategic management that encompasses not only processes but also corporate governance, managerial decision-making, and the sources of competitive advantage (TEECE, 2020, p. 234).

In other words, through the theory of dynamic capabilities it is possible to understand more clearly how the open innovation process is developed in a company.

2.2 Influence of cognitive biases on open innovation

Bogers et al. (2019) highlight that in the process of integrating knowledge from the external environment, there may be a need to change the company's organizational culture. Keeping an organization innovating over time is a very challenging mission. There are elements that hinder an organization's innovation cycle that need to be identified and remedied to avoid losses to the company (PILLER; ANTONS, 2015). Among the elements that contribute to the failure of a company's open innovation process are cognitive biases (CB). Tversky and Kahneman (1974) consider CBs as principles that reduce the tasks of evaluating probabilities and predictive values to simplify the decision-making process, that is, they act as cognitive shortcuts that individuals use to

decide on a choice. Such shortcuts, although they optimize decisions, do not always lead to the right choices.

CBs can contribute to weakening the OI strategies adopted by the company, hindering the organizational culture changes necessary for the transition from the closed research model to the more open research model. In other words, they can undermine the power and vitality of OI actions and interventions even before they are implemented in the companies or organizations. Bogers, Burcharth and Chesbrough (2021) consider that Brazil needs to eagerly make use of OI to break with these institutional ties that make innovation processes slow, to have it as an important ally in facing social challenges.

3. Methodology

The research nature is characterized as qualitative. The case study was used as a qualitative method (GODOY, 1995), as it is a method widely used in administrative contexts, among which its use for analysing institutional policies and in situations relating to public administration stands out (ALMEIDA, 2016). Face-to-face interviews as well as document analysis and inductive content analysis were chosen as sources of evidence to understand the data collected. Content analysis was used to compare the data and information obtained in interviews and document analysis, enabling the selection of content to be used in the research according to previously established criteria (data triangulation to ensure the robustness of the results). Figure 1 demonstrates the research data triangulation process.

Semi-structured interviews were the main data collection tool, which were carried out in person. Regarding conducting interviews, Yin (2002) states that this is one of the main and most important methods of collecting evidence for carrying out a case study. 14 people with a management role in the company were interviewed, 8 of whom held the position of analyst and 6 the position of researcher. The choice of the profile of the interviewees was made deliberately to meet the needs

of the research, making it a non-probabilistic sampling. The number of research individuals was determined using the theoretical saturation technique. Data collection was considered saturated when no new elements were found in the interviews, not altering the understanding of the phenomenon studied (NASCIMENTO et al., 2018). Table 2 summarizes the distribution of respondents in the survey.

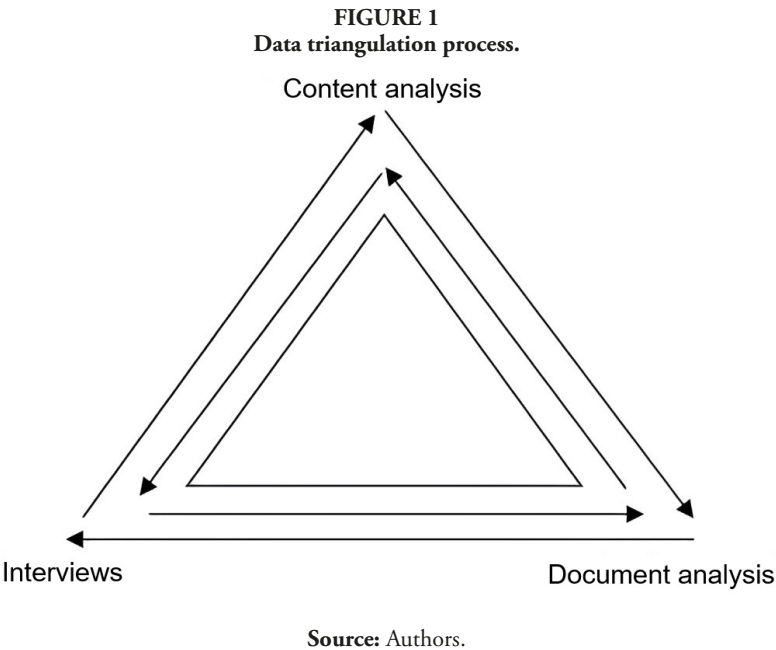


TABLE 2
Sectors interviewed and number of interviewees

Related leadership	Linked sectors	Interviewees number
General Manager	Institutional Development Center	2
Head of Technology Transfer	Programming Support Center, Organizational Communication Center, Technology Transfer Programming Implementation Sector	4
Administrative Head	Assets and Supplies Sector, People Management Sector, Research and development	5
Head of Research and Development	Fisheries and Aquaculture Thematic Center, Research and development, Internal Technical Committee	3

Source: Authors.

Regarding document analysis, Embrapa regulations related to the innovation process were analysed, in addition to documents guiding EFA's local management, the main one being the Unit Execution Plan - PEU. Moreira (2005) and Yin (2002) state that, in general, in social areas, documentary analyses are used in conjunction with other research techniques, with interviews being the main one.

Content analysis (BARDIN, 2011) was used using the qualitative data analysis software NVIVO (Qualitative Data Analysis Software – QDAS), which allowed the entire process of organization, management and categorization of data collected for the research to be carried out. QDAS are computer programs that assist researchers in managing and analyzing qualitative data extracted in the evidence collection process (SOUZA NETO et al., 2019).

The categorization of the collected data was carried out following three phases. The first of these, the preparation phase, is related to the formulation of the research question and the reading and selection of the materials that were analyzed in the study. The second phase is called the exploration phase. At this stage, the elements relevant to the research object were coded, that is, the themes contained in the sources of evidence were identified and given a definition. The definitions were then grouped into categories, using the criteria of semantic proximity and similarity. These categories were linked to a research topic that was formulated from an abstraction process carried out to group related categories (ELO; KYNGÄS, 2008). Finally, the third phase is related to the analysis of the results, where the categories were consolidated through a process of comparison between them, grouping those that were similar and/or had semantic proximity (GORTZ-BONALDO, 2021).

4. Dynamic capabilities identified in EFA's open innovation process

On the foundation sensing, the EFA has made efforts to capture and prospect the demands of the productive sector and has carried out actions on different fronts. The interviews showed that the main ones are related to the redesign and realignment of processes, as well

as the reallocation of employees with potential to work in areas directly involved with the open innovation process. Interaction has also been sought with different actors in the innovation ecosystem with a view to establishing partnerships that enable the capture of resources. Regarding this aspect, Gutierrez et al. (2022) highlight the need for companies to pay attention to events in the innovation ecosystem in which they operate to identify opportunities that arise.

Concerning the microfoundations of the feeling foundation (TEECE, 2007), Table 3 summarizes the relationship between them and the management and operational processes of the EFA that were identified and the respective perception of the interviewees.

TABLE 3
Relationship between the microfoundations of the sensing ability (TEECE, 2007) and the EFA's management and operational processes

Microfoundations	Embrapa management and operational processes
Processes for directing internal research and development work	
Creation of the company's asset management process to monitor, evaluate and determine strategies for introducing technological assets into the market.	Publication of a notice to attract candidates to form partnerships in open innovation. According to interviewee 4, this initiative "enabled a large number of companies to join and opened up awareness of new demands to be addressed."
Supplier exploration processes to complement the organization's innovations	Improvement in interaction with the market. Interviewee 12 highlighted that "the company's managers have invested in people interested in improving their negotiating capabilities with the market" to attract the demands of the production sector.
Processes for exploiting exogenous scientific and technological developments	Identification of partners with profiles that align with the company's strategy for establishing partnerships (through direct contact with the partner, both in face-to-face meetings, virtual meetings, technical events such as congresses, conferences, fairs, workshops, etc.). Interviewee 02 highlighted that in this process it is important that the partner "has experience and knowledge of the activity (know-how) and willingness to take the risks of the research".

Source: Authors.

Regarding capacity utilization (TEECE, 2007), the EFA intervened in different processes to make them more compatible - within the possibilities of a public company - with the demands of the value chain. The company's organizational structure was changed to make it possible to incorporate, more quickly, demands from the sector, enabling the formalization of partnerships with the potential to produce technological solutions for the Brazilian agricultural sector. We also sought to implement a more strategic communication process where the company's assets were highlighted to attract the private sector. Köhler, Sonnichsen and Beske-Jansen (2022) consider that effective knowledge sharing is essential for the development of dynamic management capabilities.

In relation to the microfoundations of leveraging capacity, Table 4 summarizes the relationship between them, and the EFA's management and operational processes identified and the respective perception of the interviewees.

Finally, the EFA's ability to transform has been gradual, but without the speed required by the private sector. As a public company, aspects related to the slowness of the process were pointed out by interviewee 06: "the company is still learning to behave in the context of open innovation, which means that some processes take place slowly and there is a loss of opportunities". In an environment where changes occur dynamically, this fact may constitute a complicating element in the future, considering that the ability to transform allows the rapid updating of activities carried out at the EFA depending on the intended practices and/or work habits (ANNOSI et al., 2022).

Regarding the microfoundations of the transforming capacity, Table 5 summarizes the relationship between them and the EFA's management and operational processes that were identified and the respective perception of the interviewees.

EFA's sustainable growth depends on the ability to reconfigure and recombine its assets and structures based on constant market and technology changes. Transformation implies the adoption and/or adaptation of new routines/processes whose complexity will vary according to the type of innovation achieved in the company.

TABLE 4
Relationship between the microfoundations of harnessing capacity (TEECE, 2007) and EFA's management and operational processes

Microfoundations	EFA's management and operational processes
Features introduced in the product	To improve the company's performance and deliver quality deliveries to the market, the company underwent a robust internal restructuring process. Among the changes made, interviewee 02 highlighted "the relocation of the communication sector to the TT area (technology transfer) for a more market-oriented operation". Another remodelled and enhanced process was the management of experimental fields (EF). Interviewee 08 stated that with the EFs in the unit "we can carry out projects here in an attempt to attract the productive sector". Finally, interviewee 09 highlighted "the creation of the sector of agreements and contracts with a negotiation sphere for the internalization of innovation, taking care of the procedural issue".
Defining organization boundaries	To establish the organization's boundaries, the Unit Execution Plan (PEU) was prepared with the participation of internal and external stakeholders and the production sector. Interviewee 11 highlighted that the construction of the PEU considered "the needs of the productive sector and the pain of the market".
Selection of decision-making protocols	The company's directors meet regularly to adjust the actions and procedures that will guide the company's processes. In general, the decision-making protocol related to taking advantage of market demands follows the following steps: I - identification of demand; II - levelling with company directors regarding the demand and its history (how it arose, who proposed it, where it will be held, etc.); III - verification of the availability of the technical team to meet the demand, and; IV - ideation workshop involving interested parties in realizing the demand with a view to preparing the work plan.
People's commitment to organizational changes	Periodically, meetings are held with all company employees. More frequently, meetings are also held with supervisors and their substitutes to align sectoral actions with the company's strategy. Interviewee 7 considers that "the fact that they are young researchers and analysts makes the team more willing to contribute to changes". However, when addressing the commitment of the company's employees, interviewee 13 highlighted that "in general, yes (people are committed), although there are people who do not look favourably on the company forming partnerships with the production sector" (Emphasis added).

Source: Authors.

TABLE 5
Relationship between the microfoundations of transforming capacity (TEECE, 2007) and the EFA's management and operational process

Microfoundations	EFA's operational process
Decentralization and decomposition - flexibilization of relationships and decentralization of decision making	Holding periodic meetings with supervisors and their substitutes to align actions with the company's strategy to pass on to other employees. Development of the company's strategic intelligence committee.

Source: Authors.

TABLE 5
Continuation...

Microfoundations	EFA's operational process
Co-specialization - development of technological products complementary to existing ones	Establishment of strategic partnerships with the production sector for the development of production and management protocols in the areas of fish farming and agriculture.
Governance and knowledge management - external know-how integration routines, learning and knowledge integration	It was reported that interaction with the productive sector led to improved ability to negotiate with partners. According to interviewee 1, "with each round of negotiation, new ways of negotiating are learned". In this vein, interviewee 11 stated that "exchanging information with partners helps us realize our limitations and seek to develop them". Another aspect added about improving negotiation skills was pointed out by interviewee 14: "we end up acquiring new ways of negotiating with partners, adapting communication to the interlocutor, considering whether the person has decision-making power or not. We also stopped sending the work plan outright." From this report, we can see the clear evolution of the company's business process based on more active contact with the production sector.

Source: Authors.

4.1 Open innovation capabilities required at Embrapa Fisheries and Aquaculture

By identifying the dynamic capabilities related to the open innovation process at EFA, it was also possible to identify the open innovation capabilities required in the company and necessary for the interaction actions with the private sector to flow satisfactorily and thus, the process of OI achieve success. In other words, by identifying gaps in OI capabilities, it is possible to improve DC development processes.

The interviewees' reports pointed to 05 main open innovation capabilities that the EFA needs to develop to improve its interaction with the private sector, as can be seen in Table 6.

The OI's ability to prospect partnerships is related to the DC of sensing, that is, of detecting opportunities for the company. Prospecting is related to perceiving possible futures as a way of supporting decision-making (NOVAES; SILVA; SANTOS, 2022). The agility in meeting demands is linked to DC seizing. As can be seen from the interviewees' reports, the agility in meeting demands was associated

TABLE 6
Capabilities required for the open innovation process

Dynamic capability	Open innovation capacity	Reports
Transforming	Negotiation skills	Interviewee 2 emphasized that the “team needs training in market analysis, project risk analysis and knowledge in the area of negotiations still requires training”, to make the formalization of agreements with partners more efficient. Interviewee 9 considered that “in fact, we have not yet managed to internalize the necessary skills to operate in the market”, with a path still to be covered.
Sensing	Prospecting capacity	Interviewee 8 considers that all employees must be able to capture demands for the EFA, with the need to “expand the actors who seek partnerships for all sectors of the company. All employees must be prepared to capture demands, needing to know how to direct the demand in order to satisfy the customer’s needs. Prepare employees to seek partnerships in different situations (fairs, day to day)”.
Transforming	Ability to incorporate changes	Interviewee 7 stated that “...the company’s culture is not so much open innovation, it is still focused on the culture of closed innovation” showing the need for a transition process to the OI culture.
Transforming	Improvement of internal processes	Interviewee 3 highlighted that “the company needs to understand the open innovation route, experience only comes with time, but the processes need to be better designed”.
Seizing	Agility in meeting demands	“The company is not yet agile enough to meet the demands of the production sector, it is a deficiency that we have to work on”, considered interviewee 3 regarding the need to improve in meeting market demands. For interviewee 11, it is essential for EFA to improve efficiency in innovation processes “...we need to understand that agility is essential for the success of actions with the production sector”.

Source: Written by the Authors.

with the success of actions with the value chain to take advantage of business opportunities. Taking advantage of market opportunities involves designing solutions to overcome the slowness and bureaucracy inherent to the public sector (GALDO, 2016). Brüggemann, Monteiro and Lunkes (2022) highlight that the ability to quickly meet demands is fundamental to the innovation process.

Finally, negotiation capabilities, the ability to incorporate changes and improve internal processes are related to DC transformation. Opening to the market and interacting in negotiations with the productive sector requires skills that are not learned in formal training at universities. Melo, Dias and Sell (2022) consider that carrying out a well-executed negotiation process can influence the final success of a product. Rapid adaptation to changes opening paths for the search for new knowledge related to innovation (BRÜGGEMANN; MONTEIRO; LUNKES, 2022).

The incorporation of changes arising from the external environment involves improving internal processes, which need to be adjusted to meet the demands of the private sector and, in this way, enable the company to follow “the route of open innovation”, as reported by interviewee 3. Instructing processes with quality, speed and transparency are essential for the public sector to satisfactorily meet the demands arising from the market (PANIS et al., 2022).

4.2 Cognitive biases related to Embrapa Fisheries and Aquaculture open innovation process

Through content analysis carried out based on reports collected in interviews carried out at EFA, four cognitive biases present in the company's OI process and the perception of comprehensiveness in the way it is presented (locally at EFA, or if it is something within the company headquarters), namely: not invented here syndrome (NIHS), risk aversion, possession/endowment effect and myopia, as shown in Table 7.

NIHS (Not Invented Here Syndrome) refers to a cultural bias, mainly observed in Scientific, Technological and Innovation Institutions (STI), which reflects a negative attitude of a firm's employees when considering the adoption of knowledge and technologies from external organizations (ARMELLINI; BEAUDRY; MAHON, 2018; BURCHARTH; KNUDSEN; SONDERGAARD, 2014).

TABLE 7
Cognitive biases identified in the EFA open innovation process

Biases	Reports	Coverage
Not invented here syndrome (NIHS)	The NIHS is a barrier to the adoption of OI in companies and was identified at the EFA, as can be seen from the report of interviewee 4: “The company thinks it has knowledge for everything, and that this knowledge only exists here. It remains to be recognized that external knowledge can add value.”; Interviewee 10 stated: “I have the feeling that the company is very self-absorbed and the fact that it looks at partnerships more actively is already a step forward”.	Location/ Headquarters
Risk aversion	A bias related to the insecurity caused by the change and transformation process is risk aversion. The report of interviewee 12 illustrates this bias: “...when there is financial support from the EFA, there is uncertainty about making a commitment in the future as a result of the government’s constant budget cuts”.	Location
Possession/ endowment effect	Another barrier to open innovation is the ownership effect bias, where there is a strong appreciation of one’s own knowledge, as reported by interviewee 07: “the company’s culture is not so much open innovation, it is still focused on the culture of closed innovation”. And in an allusion to the behavior of peers of thinking that EFA’s knowledge is the most relevant, interviewee 11 stated that: “with the partnership network, we can see that there are many people more qualified than us.”	Location/ Headquarters
Short term vision	Another bias perceived in the EFA’s OI process was myopia, where there is an emphasis on the current moment to the detriment of the long-term vision, as reported by interviewee 13: “...directing research towards a particular gain, risk of just having directed research, forgetting basic research.” On this point, interviewee 14 emphasized the following: “...the suffocation of basic research (is worrying), as its results are not necessarily something usable by the market.”	Headquarters

Source: Authors.

NIHS’ perception is attributed to the fact that the EFA technical team is accustomed to the closed innovation model in which internal knowledge produced by STI is sufficient. In this way, when faced with a new way of doing PDI, a behavior of resistance to change was perceived

as it affected the already consolidated *modus operandi*. In this regard, interviewee 10 used the term “self-absorbed” to characterize the fact that the company primarily values the knowledge it produces itself and that opening itself up to external knowledge is already a step forward.

Regarding the risk aversion bias, it was identified in a scenario that has as a backdrop the scarcity of resources for investment in the RDI area. Regarding risk aversion, Kahneman and Tversky (1979) highlight that risk aversion is the reluctance to make decisions that will result in uncertain returns (even involving large gains), with a preference for choices that have certain returns (even involving small gains), which favours incremental innovations to the detriment of disruptive innovations. Barbosa and Carvalho (2022) assert that risk aversion can be considered one of the main obstacles to innovation in the public service. In this sense, risk aversion was identified in a scenario that has as a backdrop the scarcity of resources for investment in the PDI area.

According to interviewee 12, there is a fear of making commitments to potential partners based on resources released by the government, because even if they are foreseen, they can be cut at any time, damaging the partnership and tarnishing the company’s image in the production sector. The risk aversion bias can contribute to more biased decision-making and a tendency to maintain the status quo, as well as making it difficult for the company to explore disruptive innovations. (TEECE, 2007)

Regarding the possession/endowment effect bias, there is a perception that the knowledge that the company possesses is more valuable than the knowledge obtained in the external environment. Litovsky et al. (2022, p.1) define the endowment effect as an “asymmetry in preferences for acquiring versus giving up objects”. Carney et al. (2022) highlight that the possession of an asset, in this case knowledge, contributes to increasing its positive evaluation, reducing the willingness to lose it or make it obsolete. Thus, this bias works as a defense mechanism to protect and value the knowledge produced by the company from knowledge coming from the external environment.

However, in the process of interacting with the market it was possible to realize that this is just a cognitive bias. As reported by interviewee 11, in the company's network of relationships, there are actors in the innovation ecosystem that are more capable and have more resources that can add their knowledge and expertise to the EFA's open innovation development process.

Finally, short-term vision bias, or myopia, is related to decisions that neglect long-term action planning, favoring short- and medium-term planning. Pitthan and De Witte (2021) state that under the effect of this bias, there is a preference for achieving benefits in a short period of time, and the environment directly contributes to short-sighted decision-making. In the case studied, the concern with adopting a "short-sighted" strategy is related to the perceived contrast between the constant incentives made by the company for open innovation partnerships (applied research) and the few resources that have been allocated to carrying out basic research.

This concern is evident in the report of interviewee 14 when he expresses the possibility of "suffocating basic research" because its results are not attractive to the market. The productive sector seeks solutions that are quick and profitable, and basic research demands time and investment. However, basic research is essential for the search for long-term solutions, especially research developed in the agricultural sector related to the country's food security. As reported by interviewee 4, "while applied research is looking for solutions to the problems of the next 10, 20 years, basic research will bring us solutions to the problems of the next 30 years."

5. Final considerations

The present study contributed to the understanding that it is not enough for the EFA to simply adopt the OI process without transforming/reconfiguring its internal processes and its dynamic capabilities to interact with the production sector. There is a need to

prepare the technical team to act according to market logic, which has occurred relatively slowly, without observing the pace demanded by the production sector.

In this way, it is important to have the process of preparing the technical team to negotiate EFA's assets that will be co-developed with the private sector, considering that the researcher is involved in an academic mentality of carrying out research in the logic of closed innovation, in generally, in isolation, without the need to make them attractive to the market.

As the prerequisite for OI is the openness to external knowledge and speed in the development of innovative solutions, it is important that the technical team knows how to interact and communicate with the market, capturing and understanding their pain points to transform them into innovative products/services/processes capable of being used promptly by the person seeking the technological solution. It should be noted that, if the company is interested in adopting OI, it must mainly come from it that the means are made available for the technical team to adapt to the new reality. The changing landscape in the direction of innovation requires a change in organizational culture, requiring the development of specific skills to perceive, capture and transform the needs of the value chain into technological solutions.

Regarding the open innovation capabilities required in the EFA (specific capabilities), 5 capabilities were identified that need to be developed to enable the company to leverage results in the process of interaction with the productive sector, namely: (I) prospecting capability, that is, the company's search for partnership opportunities in the market, related to the DC sensing; (II) agility in meeting demands, as the company needs to have structured and fast processes to take advantage of opportunities that arise in the market, related to the DC seizing (slowness and excessive bureaucracy can act as barriers to closing the deal); and; (III) negotiation capabilities, (IV) capacity to incorporate changes and (V) improvement of internal processes, as they refer to the company's capacity to transform and reconfigure its internal environment based on signals arising from interaction with the external environment (GALDO, 2016).

According to the interviewees' reports, these capabilities need to be improved to make the company capable of interacting with the market, taking advantage of opportunities and becoming attractive to potential investors. This path involves the processes of sensing opportunities in the production sector, taking advantage of them, and, where necessary, adapting its internal processes to market demands.

Finally, it was realized that there is a link between NIHS (Not Invented Here Syndrome), risk aversion, and tenure/endowment effect. Such biases are directly related to self-preservation behavior and maintenance of the company's status quo. Something that can be verified in a scenario of profound dynamism and transformations. Change is not always seen as something beneficial at first, requiring guidance and awareness-raising actions addressing the importance and benefits that the intended changes will bring to the company.

The findings of this study can be applied to other public research institutions by considering each peculiarity and context. Moreover, the methodology undertaken can be used and/or improved to be applied to other research organizations to obtain a perspective from different perspectives on how their open innovation processes are developing and unfolding.

Data Availability Statement

The data supporting the findings of this study can be requested from the corresponding author upon reasonable request.

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Declaração de Editor Responsável pelo Processo de Avaliação

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