

Interorganizational Relationships in the Amazon Biotech Industry Based on Entrepreneurs' Perceptions

Relacionamentos Interorganizacionais na Bioindústria Amazonense na Percepção dos Empresários




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Editor-in-chief: Wesley Mendes-Da-Silva 

Received 06 February 2019

Last version received at 10 May 2019

Accepted 13 May 2019

of invited reviewers until the decision

	1	2	3	4	5	6	7	8
1st round			⊗	⊗	⊗			
2nd round								
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Resumo

Diversas modalidades de relacionamentos foram adotadas nas reestruturações industriais como estratégia de sobrevivência e desenvolvimento das organizações. A bioindústria demanda parcerias dado o elevado investimento técnico-científico necessário, entretanto, dificuldades existem para concretizá-las no Brasil. Na Amazônia, onde a agregação de valor no uso dos recursos da sua biodiversidade tem elevada importância para o desenvolvimento sustentável regional, estudos apontam dificuldades de interação entre empresas da bioindústria, academia e governo. Compreender estas dificuldades motivou este estudo, que tem como objetivo analisar a percepção dos empresários acerca dos relacionamentos interorganizacionais na bioindústria amazonense. Realizou-se uma pesquisa qualitativa com treze empreendimentos cujos dados foram coletados utilizando network pictures, complementadas com entrevistas semiestruturadas. Ainda que relações de amizade, confiança, entre outros atributos, tenham sido identificados como os principais fatores relacionais e que a complementaridade de recursos seja o principal motivo das parcerias, os relacionamentos estão aquém do que se preconiza para afirmar a existência de uma rede de negócios. Estes resultados evidenciam também a necessidade proposições de ações estratégicas para aproximação dos atores desta indústria.

Palavras-chave: bioindústria amazonense; relacionamentos interorganizacionais; rede de negócios; network picture.

Abstract

The process of industrial restructuring has adopted different types of relationships in order to guarantee the organizations survival and development. Bioindustry requires high technical-scientific investments that are obtained through partnerships. These collaborative relationships, however, have been challenging in Brazil. In the Amazon context, where value adding in the use of biodiversity resources bears high importance for regional sustainable development, studies point to difficulties of interaction between bioindustry firms, university, and government. Against this backdrop, this research analyzes the perception of entrepreneurs operating in the Amazon bioindustry regarding the inter-organizational relationships. Qualitative research was carried out with thirteen firms, collecting data based on network pictures, complemented with semi-structured interviews. The study identified that attributes such as friendship and trust are primary factors in the relationships, and that the complementarity of resources is the main reason to establish partnerships. However, the findings suggest that inter and intra-sectorial relationships in this Amazon bioindustry are far behind what is recommended in literature to affirm the existence of a business network. Therefore, the study points out the need for strategic actions to approximate these actors in bioindustry.

Keywords: Amazon bioindustry; inter-organizational relationships; business network; network.

JEL Code: M130, R580, Z130.

Introduction

Relationships such as alliances and networks of firms have been subject to studies on organizations' survival since the 1980s (Gulati, 1998). The adoption of these practices as a new industrial production strategy has increased, in response to the industrial restructuring resulting from the economic dynamics that involves technology development, globalization, change in consumer culture, and organizational restructuring (Håkansson, 2006).

Particularly in bioindustry – defined as an industry that uses biotechnology and other advanced life sciences methodologies in creating or changing the form of life or process (Dictionary, com., n.d.) – advanced research is so pulverized that the skills needed for an activity cannot be centralized in only one firm (Powell, Koput, & Smith-Doerr, 1996). This industry is characterized by high technical-scientific content, high dependence on basic research, long maturation time until the introduction of new products in the market. Therefore, the reasons that justify partnership in this industry range from reduction in investment risk to needs related to R&D, financing, and marketing (Fernald, Pennings, & Claassen, 2015).

Although there are national efforts aimed at increasing national production of drugs, biopharmaceuticals, and medical equipment through inter-organizational partnerships, there are many difficulties related to these partnerships (Alves, Vargas, & Britto, 2018). In an attempt to rank the critical success factors for the Brazilian biosciences sector, consultation among the firms in the sector resulted that the option 'implementation of partnerships and collaborations' was placed second to last among fourteen items (Fundação Biomina, 2011). The same study listed thirteen challenges to be faced by firms. Items **attracting partners for co-development and licensing** and **attracting partners for marketing and distribution** ranked sixth and tenth, respectively. Such results indicate that Brazilian firms do not see the partnership as a way to overcome their main barriers.

The difficulty in cooperation is a result of the lack of comprehension about the motivation to undertake such behavior, considering the new industrial configuration that is responsible for redefining the organizational strategies. In the case of the Amazon, working in partnership through networks, as recommended by Andrade (2017), contributes to putting into practice alternatives to actions that damage the environment and are less efficient in obtaining results from the exploration of biodiversity resources. In order to understand the reality of inter-organizational relationships based on a business-driven point of view and considering the need to raise the levels of technological development and innovation in the Amazon, the question guiding this research is how do entrepreneurs of the Amazon bioindustry perceive their relationships with other local organizations?

According to Viaggi (2016), biodiversity studies target a myriad of topics, yet focus on limited problems and scientific fields. For the author, a comprehensive vision is necessary, capable of facing the challenges of the interconnections among the components of the production activity using biodiversity as an input, the different regional needs, and the different expectations. Therefore, this study fills a theoretical lack by identifying elements that help to understand, based on the entrepreneur's perception, the characteristics of the interconnections between actors of the Amazon bioindustry, as well as the interconnections between these actors and government and agents related to science, technology, and innovation. In addition, this research contributes to adding knowledge about the Amazon context to the mainstream analysis of studies on inter-organizational relationships.

The research shows that the economic activities that adopt biotechnology in products and processes in areas such as health, agriculture, and food in a region geographically distant from the large industrial centers, have the same reasons to establish partnerships like the ones observed for the enterprises established in other regions. These firms can assist in the formulation of public policies that drive the development of this industry that adopts the cutting-edge technology. Also, characteristics identified in the Amazon bioindustry may exist in other sectors. In this way, this study can contribute to research in different sectors in the Amazon region whose industrial structuring requires building partnerships, particularly the need for a relationship with science and technology institutions (STIs), government agencies, and other organizations.

This article starts by approaching the inter-organizational relationships, taking the discussion until the importance of the entrepreneur's understanding about the environment, passing through the attributes and reasons for partnerships among firms. Finally, the study discusses the findings based on an empirical point of view, before exposing the study's contributions to strategies to connect the actors of this industry.

Theoretical Framework

There has been growing interest in studies on the evolution of networks since that, because of the constant evolution, a network's structure is not stable, and none of a network's members are in a stable position (Gomes, Galina, Vicentin, & Porto, 2017). The influence of managerial cognitive structures on organizational dynamics has gained emphasis in the field of study of industrial organizations. There is an assumption that the way managers 'see the world' or their surroundings, the way they organize what they know about their reality influence their actions and organizational results (Souza, Bastos, Costa, & Macambira, 2007). Thus, it is essential to consider these perceptions in order to understand the phenomenon of a business' networks (Leek & Mason, 2009).

Researchers have developed modes to analyze the complexity of industrial systems since the 1990s, seeking to understand issues related to organizational network (Henneberg, Mouzas, & Naudé, 2006; Ramos & Ford, 2011). These models include the actors' perceptions about the world and reintroduce constructs of mental representations in their theoretical developments. They assume that each actor has an idiosyncratic and evolutionary view of the surrounding network, interacting based on their perceptions.

In recent studies, the relevance of managers' cognitive structures started to be discussed in the business network literature, being considered as crucial to the success of operations. In this case, the approach adopted is different from other perspectives explored in research on networks that tend to use variables from social network surveys to study connections (such as ties, homophily/heterophily, and closure) and distributions (for example, centrality, density, and structural failure) (Kaartemo, Makkonen, & Olkkonen, 2015). While such studies provide insights into networks, they remain focused on structures.

The study on networks when analyzing the Amazon bioindustry and its inter-organizational relationships is important because, according to Ramos and Ford (2011), firms do not choose whether they want to be in networks or not: they all are. For the authors, all firms are simultaneously networking, suggesting, soliciting, demanding, reacting, performing, and adapting activities. In this context, the following subsections present reflections on business networks, conditions for partnerships between firms, and the importance of the entrepreneurs' perception in building relationships as a strategy of business development.

Inter-organizational relationships in bioindustry

Inter-organizational relationships are relatively durable transactions, flows, and connections that occur between two or more organizations in their environment (Oliver, 1990). For Gohr, Meira, Reul, and Firmino (2015), inter-organizational relationships derive from relational approaches, among those that explain the firms' competitive advantage. The authors explain that the relational approach is based on the assumption that no organization has all the resources it needs to exist, i.e., the organizations depend on the environment. These relationships are significant because competitiveness emerges not only from the organizations' internal resources but also from the resources accessed through a network of relationships or firms.

Business networks, for Moran, Façanha, Gonçalves, and Fischmann (2012), are structures of exchange and interdependency relationships. In these networks, the interactions occur to enable cost reduction and increase the quality of products and solutions for customers, to expand distribution channels, increase the intensity of technological innovation and product development, even among competitors. For Gomes, Galina, Vicentin, and Porto (2017), this type of relationship is a contractual agreement between recipient firms and donors that explicitly specify their exchanges, sharing, or co-development of knowledge among partners.

These relationships can occur vertically or horizontally. The vertical relationships occur among organizations with complementary activities, whereas the horizontal occurs among organizations that carry out similar activities (Maskell, 2001). These types of relationship can influence the results of the partnerships. In the biotechnology sector, vertical alliances are more common and have a more significant positive impact on the development of innovations (Shin, Kim, & Park, 2016). However, the results of network participation are not similar, since the way the organization builds and coordinates its network influences the results obtained (Kamuriwo & Baden-Fuller, 2016).

As observed in the study by Billitteri, Lo Nigro, and Perrone (2013) the transition from the traditional pharmaceutical industry to the biotechnology-based industry has created positive opportunities for collaborations between new sources of technical knowledge and established firms. For this reason, since the mid-1970s, the biopharmaceutical industry, similar to the bioindustry, has increasingly resorted to partnerships among large pharmaceutical firms, and between them and biotech startups. The relationship between organizations, notably between large firms and startups, as well as enhancing results, enables startups to increase their capacity to collaborate and enhance their results (Howard, Steensma, Lyles, & Dhanaraj, 2016).

After the 2008 economic crisis, bioindustry firms in developed countries found in the partnerships a strategy not just to become efficient but to survive (Hunter, 2014). This strategy was used instead of others such as merging, reorganization, and laying offs in the industry – measures that, when adopted, did not result in any of the needed radical change. In Brazil, when analyzing the firms' interaction with universities and other agents producing knowledge and research, Paranhos (2012) identified that weaknesses and deficiencies in the relationship start because of the firms and not the other partners.

Research on intellectual property in the biotechnology sector shows that universities and foundations supporting research are responsible for registering patents, demonstrating the low participation of firms, and highlighting the role of university research in the sector (Pereira, Silva, Lavoie, & Porto, 2018). In the state of Amazonas, studies show difficulties in the interaction between bioindustry firms and university, and recommend the establishment of networks among governmental institutions (Andrade, 2017). Considering that the Amazon bioindustry comprises a structure with seven sectors that vary from human health to the environment protection, as well as counting on micro to large firms (Mafra, Lasmar, & Vilela, 2017), this research assumed as a first premise that there is a business network in the Amazon bioindustry comprising broad intra and intersectoral relationships (P1).

Relational factors of an inter-organizational relationship

The development of any relationship involves issues beyond technical aspects such as necessity, efficiency (Oliver, 1990), quality, knowledge, experience, expertise or skills, personal contacts (Powell et al., 1996), mutual commitment (Connelly, Crook, Combs, Ketchen, & Aguinis, 2018). Social interactions among entrepreneurs positively influence the innovation capacity of small firms (Hoffman, Reyes, Danda, & Veloso, 2016). Participating in associations and other groups is a way to evaluate a firm's needs regarding partnerships (Oliver, 1990). According to the author, the need for cooperation is formalized in joint ventures, industrial associations, and other arrangements seeking, among other objectives, support from public policies to promote the collective development of the activity.

Business relationships form strong and extensive social, economic, service-related, and technical ties, to reduce costs and increase value, obtaining a mutual benefit (Bagdoniene & Zilione, 2009). Connections are essential for the development of firms, including weak links, which generate opportunities and integrate them into the environment (Granovetter, 1973). Factors, such as trust in partners' competence and integrity, strengthen the bonds, and make the results more profitable (Connelly et al., 2018).

On the other hand, Jensen and Schott (2015) observe that the relationships with family and friends reduce the extension of the network of firms, negatively impacting the increase of innovation in the firms of the network. In the Amazon bioindustry, Andrade (2017) identified that entrepreneurs do not feel secure in partnerships with firms of the same activity, despite the need to increase their production capacities, market share, and exploration

of new markets. Thus, this study assumed as a second premise that relational factors such as personal contacts, trust, experience, common interests, are elements supporting the partnerships in the Amazon bioindustry (P2).

Resources involved in inter-organizational relationships

The primary explanation for the increase in the number of partnerships between firms in the global bioindustry is related to the extent of the strong complementarity of assets (acquisition of skills necessary for R&D, outsourcing or strengthen internal capacity, obtaining a technology platform, critical resources, and others) (Billitteri, Lo Nigro, & Perrone, 2013; Fernald et al., 2015). Access to shared infrastructure is a relevant item to foster collaboration. Having a better laboratory is a condition that raises the levels of research in biotechnology (Costa, Florencio, & Oliveira, 2018). This situation points to the need to strengthen the relationship between university and firms, facilitating the firms' access to the academic infrastructure (Fischer, Schaeffer, & Vonortas, 2019). This reality is not limited to university-firm relations; the infrastructure sharing also favors the relationship among firms.

Organizational networks focused on innovation are strengthened through the sharing of risks, knowledge, people, and infrastructure. Better use of these sharing possibilities raises the level of development of biotechnology firms (Gomes et al., 2017). Thus, the third premise of this study is that the need for the complementarity of resources motivates partnerships in the Amazon bioindustry (P3).

The entrepreneur's view on their surroundings

Understanding the entrepreneur's vision is an important return to the stage before forming partnerships, networks, or other initiatives. Mintzberg (1979) points out that, when dealing with contingency factors in organizations, it is necessary to identify the entrepreneurs' perception according to their real behaviors. Machado (2018) points out the importance of the entrepreneur's perceptions in the understanding of the growth process as a multidimensional phenomenon in order to understand the determinants and difficulties of growth of small technology-based enterprises. This understanding affects their ability to develop current and new relationships within the network, and thus grow using strategic actions (Moran, Façanha, Gonçalves, & Fischmann, 2012).

Mintzberg (1979) points out failures in research that are far the reality of an organization, attributing such failures to the methodology adopted. This does not mean that the perception obtained in this research is not important, but it does mean that researchers conclude how **the environment** rather than how **the perception of the environment** affects a structure. In this context, myopia over existing relationships is another factor that makes it difficult to understand the organizational reality and the composition of networks. For Anderson, Håkansson, and Johanson (1994), a restricted number of actors and interactions can be interpreted as an incomplete understanding of some network connections and relationships – what one chooses to see in their surroundings, as well as issues around uncertainties.

Wilkinson and Young (2002) present a different view. They argue that firms should not always take a broad view, explaining that some actors have a narrow view and are successful, while others need a broader perspective to ensure their feasibility. According to Czakon and Kawa (2018), entrepreneurs are more aware of the relationships with suppliers and direct customers than with other components of the value chain and indirect consumers. The authors argue that entrepreneurs underutilize relations that could strengthen their enterprise, neglecting even existing relationships. Thus, the focuses of entrepreneurs lead them to perceive and value certain relationships more than others. This myopia implies reductionist theories, with insufficient data to explain something.

These perceptions are important to understand phenomena related to a network (Leek & Mason, 2009). According to this trend of thought, each actor has an idiosyncratic and evolutionary view of the surrounding network, interacting based on each ones' perception. One tool to capture this perception is the network picture, through which subjective views of the actors are obtained on the business network – preexisting dynamics such as socioeconomic externalities and dyadic network and commercial relations – forming a representation, for an actor, of the context in which this actor's business interactions occur (Ramos & Ford, 2011).

When building their network picture, an actor portrays their perceptions about their role, their influence in the industry, and the network (Henneberg et al., 2006). The network picture may be freely illustrated, written, narrated, and later analyzed according to dimensional models, organized in interrelated blocks. Czakon and Kawa (2018) note that, unlike mental models, network pictures cannot be understood as cognitive maps since the actors' perceptions are rooted in experience and are developed throughout the interactions in the network. Therefore, the pictures are inherently dynamic, unstable with time, and idiosyncratic for an individual.

Henneberg, Mouzas, and Naudé (2006) proposed eight dimensions to analyze the contents of network pictures: (a) boundaries, reflecting the relationships that a firm has along the supply chain and beyond; (b) center/periphery, involving a focal firm with central relations and, sometimes, more distant relations; (c) actors/activities/resources, reflecting who and what was perceived as relevant in the network environment; (d) focus, on actors or relationships; (e) directionality of interactions, capturing both the flow and the interdependence within the network; (f) time/task explaining the long-term or short-term time horizon involved in the network; (g) power, reflects the degree to which firms perceive themselves as independent or dependent on one another; (h) environment, refers to the forces the entrepreneurs perceive as important.

Not all proposed dimensions need to be used to study a network picture. Leek and Mason (2009) and Ramos and Ford (2011) later regrouped and renamed these dimensions (inserting structure, positioning, activities, time, and others) while retaining the essence of the characteristics. Ramos and Ford (2011) observed that the longer the activity, the broader the actor's views on the network. They also realized that more experienced individuals have more extensive and detailed schemes than those with less experience. In studies about the Amazon bioindustry, it was observed that, due to the dimensions used to identify the aspects of the interaction, the emphasis is given on the technical variables of the relationship (human resources and capital, for example) or the view of specialists rather than the views of the entrepreneurs.

The firm's perspective on bioindustry relationships in the Amazon is explored only in work by Lima (2005), who interviewed producers in the fishing industry. The results showed that producers perceive that academic research does not meet their economic interests. The characteristics of the region, the fact that the entrepreneurs underutilize their relationships, and the relationships myopia, are elements that compromise the entrepreneurs' ability to develop new relationships within the network. The fourth premise of this study, therefore, is that the entrepreneurs of the Amazon bioindustry understand their insertion in an inter-organizational network, the dynamics of the network's activity, and the benefits regarding strategic decision making in time and space (P4).

Methodology

This study is an exploratory research since there are no research works on inter-organizational relationships in the Amazon bioindustry based on the firm's perspective and that identified the entrepreneurs' perceptions. In addition, the research adopted a qualitative approach seeking to explore as much as possible the perception of the entrepreneurs from different perspectives, using multiple case study, due to the substantial analytical benefits of the method and because it offers contrasting situations (Yin, 2015), considering that the object of analysis is the firms' relationships.

The Amazon bioindustry consists of 105 enterprises, classified as producing and/or marketing intermediate and final goods in the city of Manaus, capital of the state of Amazonas, Brazil, in the following sectors: Functional foods and beverages; pharmaceutical, therapeutic and cosmeceutical; biotechnology and related services; environment; animal health; agricultural biotechnology; industrial biotechnology, based on a study by Mafra, Lasmar, and Vilela (2017).

The sampling process was based on accessibility and interest of the entrepreneurs in participating in the interviews. They were invited by email and telephone, and the invitations continued until two entrepreneurs of each sector accepted to receive the researchers. The option of selecting at least two enterprises in each sector intended to obtain elements for comparison in the inter-organizational relationships in an intra and intersectoral perspectives. Firms

in the Animal Health and Environment sectors were the most resistant in participating, which justifies the fact that only one firm represents the Environmental sector. Table 1 summarizes the characteristics of the firms interviewed.

The data was collected through the interviewees' network picture, which is a managerial and academic research tool applied in different levels of business (industrial, organizational, sector). Henneberg et al. (2006) applied the model to managers deemed efficient in their selected activities in a wide variety of industries, from Japanese insurers to the British civil service (defense area). Ramos and Ford (2011) applied this tool to managers of diverse activities (financial, production, information technology directors) in firms of the plastic industry, and in the transport sector in European countries. Leek and Mason (2009) also applied to different managers of different activities in two engineering firms (dyadic relationship).

Among the recent literature, Kaartemo, Makkonen, and Olkkonen (2015) present a structure to be adopted in research on the individual perception of the context surrounding actors participating in alliances and business network of new international enterprises (NEI) in Internet-enabled markets.

Table 1

Characteristics of the Sample

Bioindustry sector	Firm	Characteristics
Industrial biotechnology	BI01	The firm is a spin-off established in 2016. It produces enzymes for molecular biology and develops enzyme cocktails from microorganisms (selected fungi and strains) of the Amazon biodiversity to be applied in industrial processes such as the production of ethanol, detergents, and clarification of juice and flavor enhancement.
	BI02	Micro-enterprise established in 2006. It produces Taq polymerase enzymes (polymerizes DNA from aquatic thermophiles) and Pfu polymerase (<i>Pyrococcus furiosus</i>). These enzymes expand the DNA when in high temperatures. The firm holds the expertise of replicating such enzymes.
Pharmaceutical, therapeutic and cosmeceutical	FC03	Large national firm established in Manaus in 2014. It produces allopathic medicines (tablets and capsules) for human use in different categories of diseases (oncology, rheumatology, ophthalmology, infectology, dermatology, and general practice). The production includes generic and branded medicine, OTC (over-the-counter) medication and medicine for hospital use.
	FC04	A small firm created in 2013. It markets pharmaceutical products and produces drugs through the manipulation of chemical inputs (also known as the magistral market).
Animal health	SA05	A spin-off, created in 2016. It produces animal protein from the cultivation and processing of insect larvae from the Amazon as an alternative to the animal feed industry using organic waste.
	SA06	Microenterprise created in 2009. The firm provides animal protein and operates in issues of animal health (prevention and treatment), including diagnostics, laboratory tests, and monitoring. It performs artificial insemination and conducts training on genetic improvement in bovine herds through the technique of artificial insemination and good management practices.
Biotechnology and related services	SB07	Spin-off established in 2016. The firm operates in the service of research and extraction of bioactive substances from the non-timber flora of the Amazon biodiversity. These substances can be used by the food, chemical, and pharmaceutical industry, including the area of phytopharmaceuticals and cosmetics, depending on the demand.
	SB08	Microenterprise created in 2007. It offers microbiological analysis services (typing of pathogenic microorganisms) to verify the presence of contaminants, for example, in water, air, effluents, food, among other products and environments.
Agricultural biotechnology	BA09	Microenterprise created in 2016. It produces bio-fertilizer from fish waste. The firm holds a patent for the production of bio-fertilizer, biogas, and organic fertilizer.
	BA10	Microenterprise established in 2003. It produces and sells flowers, cutting foliage, and seedlings (fruit, ornamental, native), using tissue culture techniques (micro-propagation and somatic embryogenesis).

Continue

Table 1 (continued)

Bioindustry sector	Firm	Characteristics
Functional foods and beverages	AL11	Microenterprise created in 2016. It provides food from the functional gastronomy whose preparations replace the common ingredients for bakery and general cooking, such as eggs, wheat flour, sugar, thickeners, and dyes.
	AL12	Microenterprise created in 2005. It produces distilled beverages from plant extracts and fruits native or adapted from Amazon biodiversity.
Environment	MA13	Founded in 1994, it offers industrial waste treatment services and performs the re-refinement of used and contaminated lubricant oil, among other activities.

Note. Symbols for firms are based on the bioindustry sectors' name in Portuguese. Source: Field research, 2017 and 2018.

As for Czakon and Kawa (2018), they used the model in the Polish logistics services industry. For this study, the interview script was based on the dimensions of Henneberg et al. (2006), in the theories of network of firms and inter-organizational relationships, which were grouped as shown in Table 2.

Table 2

Analytical Matrix of Inter-Organizational Relationships in the Amazon Bioindustry

Dimension	Objectives	Source
Structure and boundaries (actors, nature)	It seeks to identify in how many relationships a bioindustry firm is involved in the processes of supply and demand of goods and services, identifying the nature of these relationships (whether public or private, for example). These constructs allow identifying the boundaries or horizons perceived by the entrepreneurs.	Oliver (1990); Henneberg et al. (2006); Leek and Mason (2009).
Positioning / Power / Personal positioning / Attributes	Intends to identify whether the firms consider there is a focal firm or maybe a focal relation in this industry; whether the inter-organizational relationship involves power or relationship of dependency; whether there are links that may be correlated as the different parts depend on each other; and which attributes matter in a relationship (such as trust, friendship, experience, and size).	Granovetter (1973); Powell, Koput, and Smith-Doerr (1996); Maskell (2001), Bagdoniene, and Zilione (2009), Henneberg et al. (2006); Leek and Mason (2009); Ramos and Ford (2011); Connelly, Crook, Combs, Ketchen, and Aguinis (2018).
Activities / Resources /	It aims to identify specific roles or activities in the Amazon bioindustry relationships, as well as resources traded and the reasons for the interaction.	Oliver (1990); Håkansson (2006); Henneberg et al. (2006); Ramos and Ford (2011); Billitteri et al. (2013); Fernald, Pennings, and Claassen (2015); Howard, Steenmsma, Lyles, and Dhanaraj (2016); Gomes et al. (2017); Fischer, Schaeffer, and Vonortas (2019); Costa, Florencio, and Oliveira (2018).
Environment and dynamic	It seeks to identify forces that escape the action of the entrepreneur, but influence the activities of the firm and the evolution of its relationships. It also aims to identify the time horizon perceived for the firm's business in the bioindustry (for example, intent to exploit a long-term business opportunity). Other elements are considered in the relationships in this industry, such as aspirations, problems, and uncertainties).	Henneberg et al. (2006), Leek and Mason (2009); Ramos and Ford (2011), and Hoffman, Reyes, Danda, and Veloso (2016), Czakon and Kawa (2018).

Note. Source: Adapted from Leek, S., & Mason, K. (2009). Network pictures: Building a holistic representation of a dyadic business-to-business relationship. *Industrial Marketing Management*, 38(6), 599-607. <https://doi.org/10.1016/j.indmarman.2009.05.013> and other authors in the table.

Interviewees were asked to illustrate on a sheet of paper their inter-organizational relationships, indicating key entities for their activities. To overcome possible limitations related to **little information illustrated**, when using the network picture in a more interpretive manner, the research follows recommendations by Henneberg et al. (2006) and Leek and Mason (2009) who observe that an additional methodology is necessary in order to understand the logic that supports the network pictures.

The analysis of the collected data involved interpretation and comparison of the network pictures illustrated and/or narrated by the interviewees, in an iterative process between the interviews, reviews, and literature analysis. To ensure the credibility of the research, multiple secondary sources (scientific articles on inter-organizational relationships, sectoral studies, for instance) and primary sources (researchers' observations and re-interviews with the interviewees, when necessary) were consulted, which allowed triangulation of theories to obtain perspectives for the same data set, as instructed by Yin (2015).

It should be noted that the network picture allows a researcher to influence the results when creating 'their own' image of what is the actor's perspective of the business network. Also, Ramos and Ford (2011) point out that whenever visual and verbal data conflict on a specific subject, the subjective interpretation of the researcher is necessary. The data were arranged in a table, by dimensions and elements or sub-dimensions (Ramos & Ford, 2011), which allowed to identify similarities and dissonances in the relationships among other characteristics. Only four of nine network pictures are presented in the following subsections to support their narratives.

Results and Discussion

This section presents the inter-organizational relationships of the Amazon bioindustry, based on the perspective of the entrepreneurs, organized according to the dimensions mentioned proposed above (Table 2).

Structure and boundaries (actors, nature)

Each respondent included in their network pictures a different number of organizations with which they relate, revealing the extension of the relationship. The number of organizations the respondents indicate in their network picture varies from 02 to 14, as shown in Table 3. They were organized in groups: government, university, firms, and society. This grouping is based on the need to strengthen the so-called quadruple helix, with interaction between the university, government, the third sector, and the community as a whole. This model of quadruple helix, among other characteristics, highlights the importance of the business environment to generate results based on innovation and the creation of new firms (Carvalho, Aveni, Coimbra, & Montilha, 2017).

Table 3

Relationships of Firms With Governments, STIs, Other Firms And Groups

Nature of organizations	Industrial biotechnology		Pharmaceutical, therapeutic and cosmeceutical		Animal health		Biotechnology and related services		Agricultural Biotechnology		Functional foods and beverages		Environment
	BI01	BI02	FC03 ^a	FC04	SA05	SA06	SB07	SB08	BA09 ^a	BA10	AL11	AL12 ^a	MA13 ^a
STIs	3	3		3	3	1	3	3	3	2	1	2	
Governmental agencies				1	1	4			3	8	2	2	
Private firms – horizontal or vertical partnerships		2	4		1	1			4	1		3	
Group (suppliers; clients; professionals) and associations/networks/class organizations	6	1	1	1	2	3	6	3	1	3	8	2	2
Total	9	6	5	5	7	9	9	6	11	14	11	9	2

Note. Source: Field research (2018).

^a Narrated network picture (no illustration).

As observed in Table 3, the network pictures that presented more organizations in relationships were the pictures of the startups AL11 and BA09 and of the firm BA10. The results found for these startups was inconsistent with the studies of Ramos and Ford (2011) that established a positive relationship between time in activity and the actor's view of the network. The factor that contributes to the number of AL11 relationships is the various brainstorming groups in which the entrepreneur participate (8, on average), as shown in Figure 1. Establishing relationships with groups of different natures (e.g., specialists, suppliers, customers) is a feature strongly identified in all network pictures.

More partners may be favorable for the growth of startups, as Machado (2018) points out. In the case of BA09, as soon as they started producing bio-fertilizer in an artisanal way, the entrepreneur sought several STIs to validate the process, for which he obtained a patent: "I sought INPA for nutrient analysis because I was concerned with the legalization of the product. I then went to EMBRAPA to test the product." According to Billitteri et al. (2013), the biotechnology activities in this type of industry require relationships from the beginning of the organizational development.

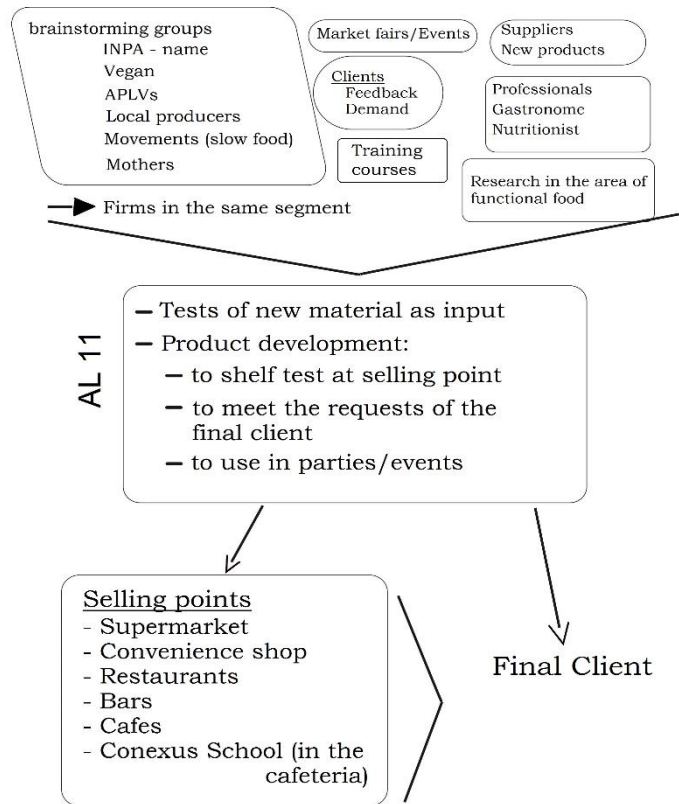


Figure 1. Network Picture of AL11
Source: Field research (2018).

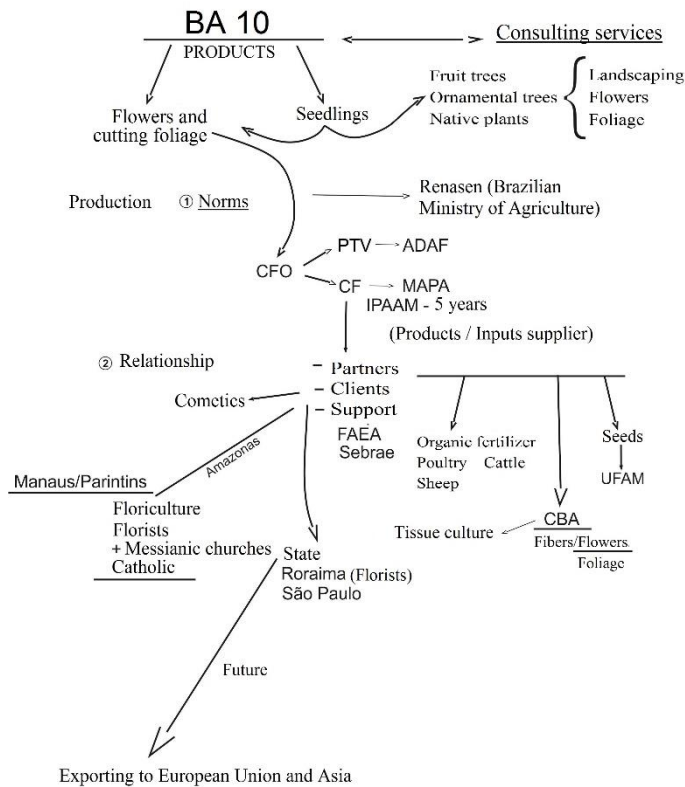


Figure 2. Network Picture of BA10
Source: Field research (2017).

The fact that some firms include more organizations than others in their network pictures indicates that they know who they can count on and for what type of situation. This was observed in BA10, a firm with more time of activity, as shown in Figure 2. However, BA10 perceive the majority of their relationships as normative and compulsory, since the firm's activities need to be authorized by regulators such as the Ministry of Agriculture, Livestock, and Supply (MAPA). The large number of relationships illustrated by this firm corroborates with Ramos and Ford (2011) who positively relate experience with widespread schemes. However, this is not the rule, since MA13 was the firm with the lowest number of relationship according to its network picture. The firm did not show interest in horizontal relationships.

When asked about relationships with firms that perform similar activities, the respondent stated: "We have a good relationship but not partnership. We exchange information on some problems, but informally" (MA13). This result corroborates with Anderson, Håkansson, and Johanson (1994) for whom entrepreneurs usually think only about the firms or actors they consider relevant to their activities; and with Wilkinson and Young (2002) for whom some actors have a narrow view and are successful, as observed in the case of MA13.

Regarding institutions such as class organization, networks, and membership associations in the network pictures, the participation in the Chamber of Bioindustry, which is held periodically by the State Secretariat for Planning and Economic Development (SEPLANCTI) was the most cited activity, followed by sector meetings of the Federation of Industries of the State of Amazonas (FIEAM). On this behavior, the firm AL11 stated: "I think it is crucial to participate in brainstorming groups because they are occasions in which we discuss nutrition, the potential of regional inputs as ingredients, opportunities for product dissemination, training, courses, and about the demands" (AL11). Oliver (1990) notes that participating in associations, networks, and other spaces are ways to identify the need for the firm to establish partnerships.

Many government agencies were included in the entrepreneurs' network pictures of the entrepreneurs, and the Amazonas State Foundation for Research Support (FAPEAM) is the most cited, followed by SEPLANCTI. The main reasons for the relationships are related to the economic subsidy, intermediated by FAPEAM, and participation in forums that deal with topics of interest to firms, organized by the Chamber of Bioindustry, SEPLANCTI. A significant number of STIs were included in the network pictures, with the National Institute of Amazonian Research (INPA) and the Federal University of Amazonas (UFAM) being the most cited, indicating the importance of the university to Amazon bioindustry firms, as identified by Pereira, Silva, Lavoie, and Porto (2018). Other STIs were included in the narratives but without much emphasis on the relationship. The relationships with other firms are significantly vertical, corroborating with Shin, Kim, and Park (2016).

Derived from Table 3, Figure 3 illustrates these relationships. It was possible to see that, in the intra-sectorial level, few firms work in partnerships with a company of the same sector. This type of partnership occurred in two situations: (a) the partner company was not located in the State of Amazonas (a partnership among BI01, BI02 and SA06; and (b) a firm works with a competitor to meet any extraordinary demands (case of BA10). An **intent** of SA05 to collaborate with local firms of the same sector was also identified.

At the inter-sectorial level, the firm BA10 had partnerships with firms in the animal health and pharmaceutical, therapeutic and cosmeceutical sectors, and the firm SB07 had a partnership with a firm in the pharmaceutical, therapeutic and cosmeceutical sector. An **intention** of SA05 was also identified to establish a partnership with a firm of the pharmaceutical, therapeutic and cosmeceutical sector.

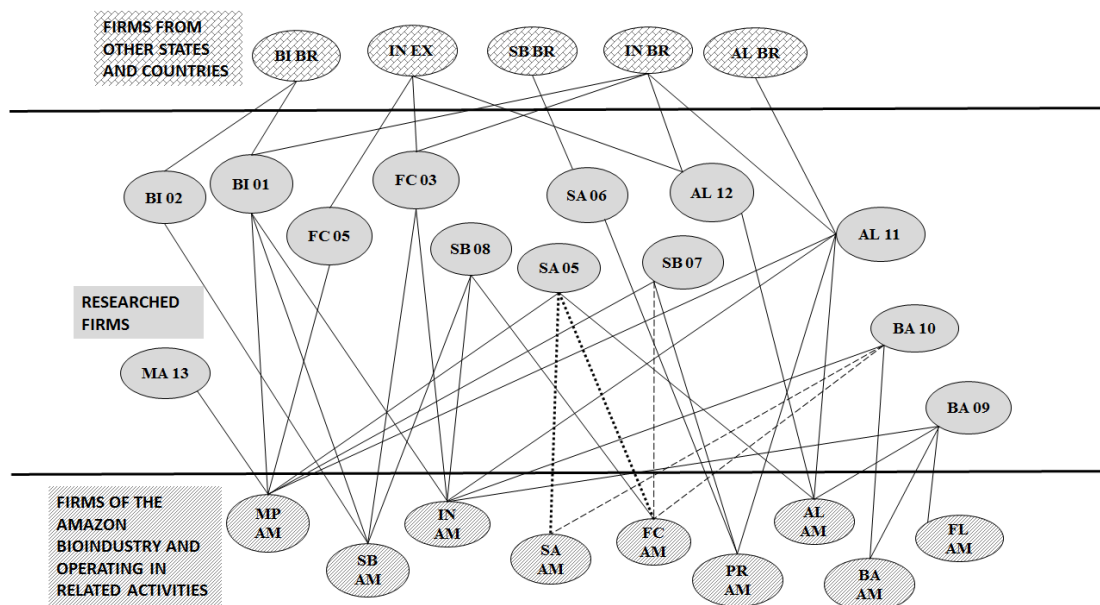


Figure 3. Relationships Among Firms of the Amazon Bioindustry

Note. The first two letters of the symbol that designate the firms represent the bioindustry sectors (in Portuguese), using the same symbol adopted for the firms interviewed. The following terms were added (also regarding the designation in Portuguese): MP – for a raw material supplier, IN – for input supplier, SB – for biological and related services, PR – for independent professional, and for FL – Floriculture. The final two letters represent the firms' location: AM – State of Amazonas, BR – Brazil, EX – International. Dashed lines represent partnerships between firms from different sectors, and dotted lines represent the intention of the firms to form partnerships. Source: Field research (2018).

The identities of these partner firms were not revealed to the researchers. In this sense, although some types of relationships have been identified, they are not practiced in intensity and quality by a representative number of firms, as observed in the **web of relationships** in Figure 3. Also, these relationships did not meet the requirements to be characterized as part of a network of business enterprises as established by Gomes et al. (2017) and Moran et al. (2012).

Business network theories consider the existence of interdependence of purposes based on collaborative connections for production, distribution, customer solutions, product quality enhancement, research and development, coordination, cost reductions, among other aspects, and the outcome of networks pictures invalidates the first premise (P1) of this study. Therefore, the business network in the Amazon bioindustry is small, and the intra and inter-sectorial partnerships are rare.

Positioning/power/personal positioning/attributes

The characteristics of this dimension were extracted from the interviewees' discourses, a condition foreseen in the methodology as **follow-up discussion**. As shown in Table 4, the social ties that predominate in the entrepreneurs' network pictures are the academics (in BI01, BI02, SA05, SB07, SB08, and BA10), corroborating with Powell et al. (1996).

Table 4

Attributes of the Relationships Narrated in the Network Pictures

Attributes	Industrial biotechnology		Pharmaceutical, therapeutic and cosmeceutical		Animal health		Biotechnology and related services		Agricultural Biotechnology		Functional foods and beverages		Environment
	BI01	BI02	FC03	FC04	SA05	SA06	SB07	SB08	BA09	BA10	AL11	AL12	MA13
Friendship ties										X	X		
Professional ties				X		X			X	X			
Academic ties	X	X			X		X	X		X			
Trust	X		X	X	X	X	X	X	X				X
Commitment						X					X		
Competence, academic degree						X					X		X
Proximity/geographical location					X				X				
Business language/vision of future			X								X		
Service quality										X			
Culture						X							
Other (resource for research; modern equipment; experience in partnerships; potential for technology transfer)			X										

Note. Source: Field research (2018).

Regarding the friendship ties, the AL11 narrates that it was only able to carry out some tests on its product because she knew a researcher from INPA:

When I was developing the first products, I had to carry out tests of recipes that replaced the most common ingredients in the traditional cuisine, so I sought guidance from the local STIs, but I was only able to carry out the tests later on, because I met a researcher who participated in the brainstorming groups and we became friends (AL11).

Friendship ties, however, does not necessarily lead to cooperation in a horizontal relationship. This is the case of MA13, whose respondent said they “exchanged information ... but informally” with competitors, which corroborates with the research by Jensen and Schott (2015). It is understood that the inter-organizational relationships in this industry are informal, and the partnerships are maintained because of friendship ties. It is important to emphasize, however, that informality is inherent in the construction of collaboration in which the exchange of knowledge is based on mutual trust, corroborating with Connelly et al. (2018). These characteristics result in intensive and comprehensive relationships; different from market relations and hierarchical environments. So much so that the most mentioned attribute in network pictures was trust.

The MA13 interviewee stated that the firm did not establish partnerships with others carrying out similar activities: “We cannot guarantee the service of third parties, whether the waste will be treated properly and whether the ‘partner’ will have the same commitment as our firm” (MA13). The importance of trust and commitment in a relationship is noted in this statement. The trust linked to product quality was also stated by BA10 when asked about horizontal partnerships:

When I need to meet a demand and do not have enough product, I turn to a rural producer with an activity similar to mine. However, I observe the quality of the material used by this producer and the type of product, their history as a supplier – previous contacts, and the similarity of culture.... But the responsibility of going there and selecting the product lies on my employees. These same employees carry out the post-harvest process on the premises of the partner firm. If the material is not to standard, it will be discarded (BA10).

It was also observed a relationship between the entrepreneur's academic degree and the professional ties established, confirming what had already been observed by Powell et al. (1996) on the convenience for entrepreneurs to partner with researchers. On the other hand, the AL12 respondent, who holds a doctorate in chemistry and extensive experience in scientific research, stated: "I have no interest in collaborating with an STI because it is 'complicated' and I do not have motivation either." The respondent did not clarify what type of complication they were referring to.

Other desirable attributes cited were the proximity/geographical location, commitment, competence, and academic degree, quality of service or product, speak the same business language, sufficient allocation of resources for research, the potential for technology transfer, modern equipment, and collaborative experience with STI. This result validates the premise P2, which states that factors such as personal contacts, trust, experience, and common interests support the partnerships in the Amazon bioindustry.

Activities/resources

When grouping the individual network pictures, it is possible to note overlapping regarding the reasons leading the firms to establish relationships with other organizations, as shown in Table 5. In addition to the acquisition of raw material and inputs, other reasons to collaborate were observed, such as **knowledge/research result/technology**, and **access to infrastructure** to use equipment. The interviewee SA05, discussing the production of animal protein, gave an example: "We are developing an automation system for the process of creating the black soldier fly INPA is responsible for research on the digestibility and for the development of the fish that feed on the larvae meal that the firms produces."

Table 5

Activities/Resources Illustrated and Narrated in the Network Pictures

Activities/resources	Industrial biotechnology		Pharmaceutical, therapeutic and cosmeceutical		Animal health		Biotechnology and related services		Agricultural Biotechnology	Functional foods and beverages		Environment	
	BI01	BI02	FC03	FC04	SA05	SA06	SB07	SB08	BA09	BA10	AL11	AL12	MA13
Infrastructure	x		x	x	x	x	x	x	x				
Inputs acquisition	x		x			x			x	X	x	x	x
Acquisition of raw material	x				x		x		x	X	x	x	x
Services in general										X		x	x
Human resources	x		x		x								
Knowledge/research results/technology	x			x	x		x		x		x		
Economic subsidies			x										x
Technology transference			x										
Licensing			x										
Technical assistance							x						
Legal matters										X			
Event/publicizing the product											x		x

Note. Source: Field research (2018).

This approximation strategy is positive, and indicates that there are entrepreneurs who need to work in collaboration to access resources they do not have and there are other entrepreneurs who have; in this case, intellectual resources. This behavior is in line with Håkansson's (2006, p. 154) observations, "business relationships are interesting from a knowledge standpoint because they are related to learning in various ways." In the interaction between the firms and the STIs, resources such as 'infrastructure' and 'knowledge/research results/technology' are the ones that attract partnerships, particularly between startups:

Working with a microorganism is not a predictable thing, and often it is necessary to repeat the experiment over and over again. If there is a power failure, the work is lost and, even if there is a generator, the equipment does not fully function, since the no-break does not support it properly (BI01).

The **infrastructure** is among the main reasons why firms seek partnerships in a horizontal relationship or in a university-firm collaboration (Costa et al., 2018) and the result of this study corroborates with Gomes et al. (2017) on raising the level of development of biotechnology firms. The services to which the firms refer are laboratorial, training, transportation, consulting, technical assistance, gas supply, participation in event/product publicization, technology transfer, licensing and regulatory aspects.

Mentioned by entrepreneurs from different sectors of the bioindustry, the institutions INPA and UFAM, which are the oldest STI in the state of Amazonas, have been hosting academic projects. Five firms that are part of this study use the facilities of UFAM for the development of their activities and, together with other firms of the study, demand research, tests, and laboratory analysis of INPA. These data support the third premise of this study (P3), according to which the need for the complementarity of resources and infrastructure motivates the partnerships of firms in the Amazon bioindustry.

Environment and dynamic

Financing necessary for the expansion of activities, trade-off between working in the laboratory and business management, and regulatory and bureaucratic issues, are factors that interfere in the activities of the enterprises, as shown in Table 6. In their narrative, the interviewee of BI01 considers the financing issue the most important for the firm, because of the investments in equipment for product development: "The infrastructure I share here in the [STI] incubator will not attend my activity when I increase the scale of production, because the use of available equipment will be compromised." Funding, according to Billitteri et al. (2013), is extremely important for the high-tech industries in general, and the biotechnology industry, especially for startups.

Table 6

Environment and Dynamic Illustrated and Narrated in the Network Pictures

Environment and dynamic	Industrial biotechnology		Pharmaceutical, therapeutic and cosmeceutical		Animal health		Biotechnology and related services		Agricultural Biotechnology		Functional foods and beverages		Environment
	BI01	BI02	FC03	FC04	SA05	SA06	SB07	SB08	BA09	BA10	AL11	AL12	MA13
Need of financing/capital	X								X				
Tradeoff between laboratory and management	X	X											
Bureaucracy/normative aspects		X			X					X			
Tax incentives (Manaus Free Zone)			X										
Narrates/illustrates present situations	X		X	X	X	X	X	X	X	X	X	X	X
Narrates/illustrates past situations		X	X	X									
Narrates/illustrates future situations	X		X	X	X		X	X	X	X	X	X	X
Narrates/illustrates projections for the local market	X	X	X	X	X	X	X			X			X
Narrates/illustrates projections for the national market	X	X	X	X			X			X			X
Narrates/illustrates projections for the international market									X			X	

Note. Source: Field research (2018).

Regarding the trade-off between working in the laboratory and management, interviewee BI02 works hard to dedicate simultaneously to the research and administrative issues, as it is extracted from the discourse: “I see everything as bureaucracy, it is difficult to conciliate administrative and management activities when both require dedication. I want to have a team doing research and another in the management so that I can focus on strategy.” (BI02).

The MAPA and National Sanitary Surveillance Agency (ANVISA) are the entities most cited by some firms. For two of them, the bureaucracy delays the authorization of activities ranging from one year (SA05) to five (BA10): “The request for registration with MAPA was sent almost a year ago, and I still cannot market my product.” The perception of the bureaucracy, while inhibiting the firm’s operation in the activity, serves as an opportunity for the actors of the bioindustry to unite to face it, formulating actions – such as those observed by Machado (2018) – that minimize the impacts of these aspects.

Since networks pictures allow us to illustrate how things used to be in the past, what they have become and what is expected to happen, this temporal element is observed in most firms, as shown in Figures 4 and 5, ranging from **launch of new products** to **acting in new markets, national and international**.

- Enzymes applied to several industries

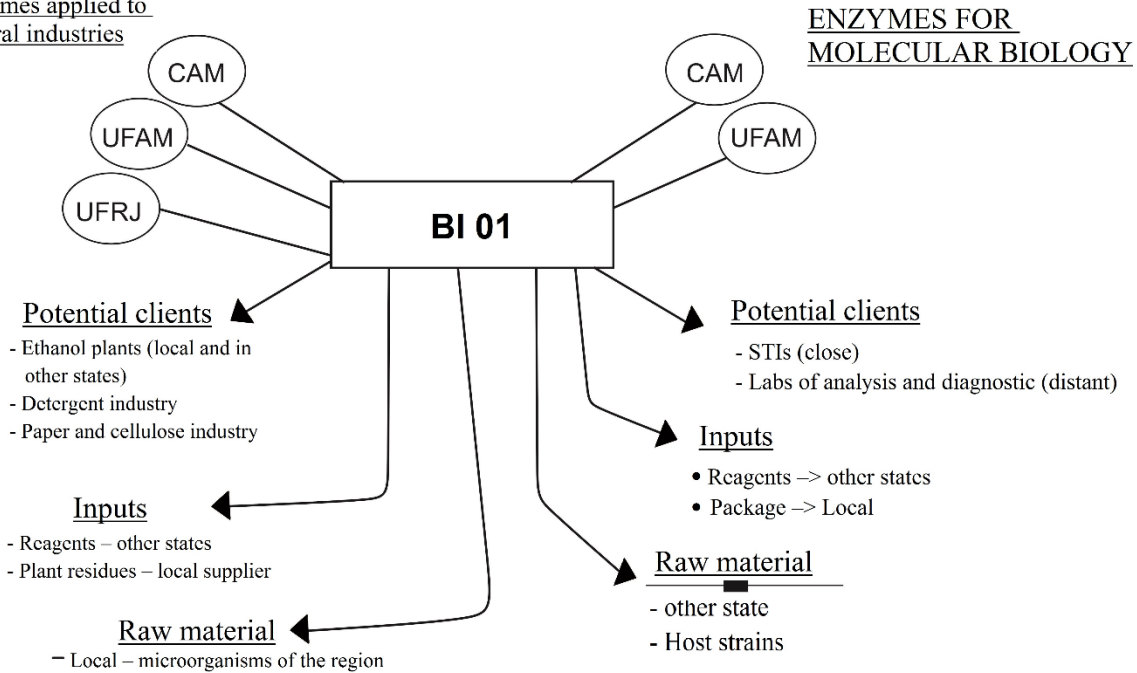


Figure 4. Network Picture of BI01
Source: Field research (2017).

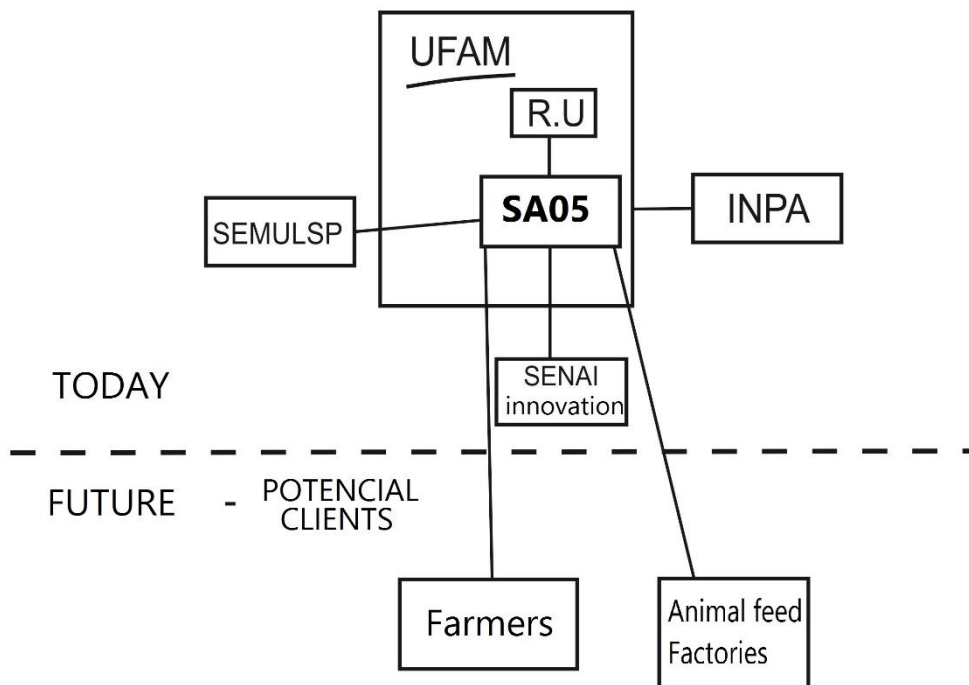


Figure 5. Network picture of SA05
Source: Field research (2017).

The firm BI01 includes the present and the future, and narrates in a follow-up conversation: “My current clients are local life science researchers of STIs, [since enzymes are heavily used in research in this area of knowledge]. The future [clients] are local and regional diagnostic laboratories.”

It was possible to observe the monitoring of activities and resources beyond those of the firm, i.e., of other firms with similar activities (competitors). The firm FC04 stated to have observed the sale of suntan lotion and intimate soap in a large local bio-cosmetics store, without authorization from ANVISA for marketing: “I am aware that many firms are not regulated, and stamp labels on their products with information that is unrelated with the authorization for production.”

Regarding the geographic element identified in the network pictures, the FC04 plans are to expand almond planting and phytotherapeutic production: “This is feasible given the degree of purity that we can achieve with the technology developed, and works as standard in scientific analysis.” These characteristics are positive regarding expanding boundaries and the organizational strategy the individual uses to support their actions (Leek & Mason, 2009), and corroborates with Kamuriwo and Baden-Fuller (2016) who states that the way the organization constructs and coordinates its network influences the results. If they indicated a static perception, this would mean greater resistance on the part of the entrepreneur to change.

Thus, the elements in this fourth dimension observed in the entrepreneurs' network pictures (aspirations, problems, uncertainties, observation of the surroundings, externalities, and others) support the fourth premise (P4). The premise stated that the understanding of the entrepreneurs of the Amazon bioindustry about the business network helps them in the strategic decision-making process by identifying the time and space horizon of this decision (e.g., intention to explore a long-term business opportunity).

Final Considerations

This study has advanced in the literature on network picture by identifying the entrepreneurs' perceptions of the inter-organizational relationships in a bioindustry. Although the network picture has been adopted in European studies related to industrial networks, the use of this tool in this type of industry is an innovation. As a theoretical contribution, the use of the network picture allowed the identification of aspects of the cognitive structure of the entrepreneurs of the Amazon bioindustry and the phenomena related to the surrounding network, formed by public agents and science, technology, and innovation institutions, as well as with the other agents, representative of society.

The thirteen cases studied showed how understanding the entrepreneur's perception about the attributes and motives within relationships, as well as understanding their surroundings, can help in the formulation of strategies to approach the actors of this industry. In addition, the result builds knowledge about the reality of Amazon science and technology to the mainstream analysis of studies on business networking and inter-organizational relationships.

As a practical contribution, this research showed the model of network picture as a valuable tool for identifying not only where relationships exist, but also where they do not exist, and therefore, where they are needed. Among the results, this study revealed that inter-organizational relationships in this industry have not yet reached sufficient intensity to form a network of firms to strengthen the firm's activities without being exclusive about financial aspects. Another practical application refers to the possibility of adapting and replicating the methodology to other economic segments, as well as adopting it in other areas of knowledge.

Among the limitations, the research may reflect the interest of the respondents, not highlighting the relationships they effectively maintain but the ones they desire to establish. Also, it is possible that evidence in data collection may be misinterpreted. These limitations, however, do not compromise the results achieved due to the scientific rigor used and the alignment with results obtained in other research works.

Future studies may combine quantitative tools (such as Social Network Analysis) which can measure, for example, experience, and ties between actors, assigning them value according to the levels of collaboration (vertical and horizontal) by groups of relationships, in a bi or multidirectional analysis. In addition, further studies may focus on in-depth behavioral and semiotic works that analyze the positions in which the entrepreneurs included themselves in the illustrations collected for this study (they positioned themselves above, or in the center, or at the side of the picture).

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Contributions

1st author: Research design, theoretical and methodological development, application, writing and final revision

2nd author: Methodological development, continuous advising and settings and final revision

3rd author: Methodological development, continuous advising and settings and final

Funding

The authors reported that there is no financial support for the research in this article.

Conflict of Interest

The authors have stated that there is no conflict of interest.

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