

Original Article

Externalities in global value chains: fishing industry in the Brazilian Amazon region

Externalidades em cadeias globais de valor: atividade de pesca na região amazônica brasileira

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ABSTRACT

Purpose – The purpose of this article is to identify externalities in the chain and recommend strategies for the participating companies to either avoid or, at the very least, minimize negative externalities.

Design/methodology/approach – case study, utilizing data obtained from different sources, including interviews and observations, in addition to other sources such as government documents, videos, and reports.

Findings – The lack of a holistic approach to the supply chain hinders value generation in the region. Some externalities generated are prices below their potential, environmental consequences, and the perpetuation of social issues in the region.

Research limitations/implications – The limitations of this study are related to the method adopted and the volume of conducted interviews. Thus, as in case studies, the results cannot be generalized. As a suggestion for future studies, replicating the method in other supply chains are suggested, which could be useful to confirm the mapping and analysis of the supply chain, considering the perspective of each link, covering them completely for a complete and detailed analysis.

Practical implications – The analysis should not consider the success of an individual participant or node in isolation. For the supplies chain to be competitive, it is not sufficient for only a few nodes or participants to achieve positive results.

Social implications – avoidance of environmental consequences and the perpetuation of social issues associated with the region.

Originality/value – A holistic approach to the production chain can generate value in the region, avoiding negative externalities.

Keywords: Negative externalities; Global value chain; Supply chain; Brazilian Amazon region; Arapaima Gigas fish

RESUMO

Objetivo – o objetivo deste artigo é identificar externalidades na cadeia e recomendar estratégias para as empresas que dela participam para que se evite ou pelo menos sejam minimizadas as externalidades negativas.

Métodos / abordagem – estudo de caso, com dados obtidos em diferentes fontes, através de entrevistas e observações, complementados por outras fontes como documentos de fontes governamentais, vídeos e relatórios.

Principais resultados – a falta de uma abordagem holística na cadeia impede a geração de valor na região. Algumas das externalidades geradas são preços abaixo do potencial, consequências ambientais e continuidade de questões sociais na região.

Limitações e implicações da pesquisa – As limitações do presente estudo estão relacionadas ao método adotado e o volume de entrevistas efetuado. Como ocorre nos estudos de caso, os resultados obtidos não podem ser generalizados. Como sugestão de estudos futuros, a replicação do método em outras cadeias é uma sugestão que poderá ser útil para confirmar o mapeamento e análise da cadeia, com a perspectiva de cada um dos nós, o que possibilitaria uma análise mais detalhada.

Implicações práticas – a análise não deveria considerar o sucesso de um participante ou nó individualmente. Para que a cadeia seja competitiva, não basta alguns nós ou participantes obterem resultados positivos.

Implicações sociais – evitar consequências ambientais e a continuidade das mazelas sociais associadas à região.

Originalidade/valor – Uma abordagem holística da cadeia produtiva pode criar geração de valor na região, evitando externalidades negativas. Palavras-chave: Externalidades negativas, Cadeia Global de Valor, Cadeia de Valor, região amazônica do Brasil, peixe Arapaima Gigas.

Palavras-chave: Externalidades negativas; Cadeia global de valor; Cadeia de valor; Região amazônica do Brasil; Peixe Arapaima Gigas

1 INTRODUCTION

The idea of external effects or externalities has been in the economics literature for decades (Buchanan & Stubblebine, 1962; Davis & Whinston, 1962), being associated with networks (Katz & Shapiro, 1985), with the discussion advancing into the decade of 1990, first in the industrial organization field (Chou & Shy, 1990), increasing in importance as years passed, being used in several circumstances (North, 1991), and finally entering the field of business and management (Westland, 1992), being used to understand firm's strategy (Garud & Kumaraswamy, 1993), value creation (Stabell & Øystein, 1998), and the conclusion that in inter-organizational systems, externalities play a major role in how firms realize benefits from these systems (Riggins, Kriebel, & Mukhopadhyay, 1994).

Although the environmental discussion is an important issue discussed in this paper, it is not limited to it. It is recognized as a valid conclusion that when the environment is considered, there are differences regarding externalities (De Marchi, 2012). Firms play a central role in addressing climate crises (De Marchi & Gereffi, 2023). The lack of skills by actor firms can give rise to negative externalities, and designing supply chains in the context of developing countries is challenging and unique due to the uncertain environment (Akenroye, Oyedijo, Rajan, Zsidisin, Mkansi, & El Baz, 2023). For example, horizontal collaboration strategies can mitigate environmental externalities (Basso, Ibarra, Pezoa, & Varas, 2023). Regarding externalities, firms differ. Thus, different measures may be applied by each business (Gebhardt, Spieske, Kopyto, & Birkel, 2022). More proactive approaches have been proposed to multinationals regarding externalities (King & Shaver, 2001; Montiel, Cuervo-Cazurra, Park, Antolín-Lopez, & Husted, 2021). However, in any chain, we can find externalities and act to mitigate and/or avoid them. Thus, this is the research gap we try to address in this article: focusing on negative externalities in the chain, if and how businesses can mitigate and/or avoid them. Our research question is: What are the negative externalities in the chain, and how can businesses act to mitigate and/or avoid them? Our primary level of analysis is the chain; then we go to then we go down to the business level of analysis. Thus, the objectives of this article are (i) to identify externalities in the chain and (ii) to recommend strategies to firms in the chain on how to mitigate and/or avoid negative externalities. With these objectives in mind, we use the context of two fishing chains in the Amazon region in Brazil to answer the research question and achieve the goals of this article. One of the chains is extractive, located in the state of Rondonia, and the other is fish farming, with its pole in the city of Manaus, capital of the Amazonas state. Both states are located in Brazil's Northern region. The fish is the *Arapaima Gigas*, also known as pirarucu, and each one of the chains has particular characteristics.

The organization of *Arapaima gigas* extractive activity is developed based on capture licenses. The extractive chain model, in addition to complying with legislation

that seeks to prevent the extinction of the species, offers communities an opportunity for work and income. The process begins with counting the animals in the sustainable development reserve (Reserva de Desenvolvimento Sustentável, RDS). Next, the number of animals authorized by the Brazilian Institute for the Environment (Instituto Brasileiro do Meio Ambiente, IBAMA, the government body in charge of formulating and implementing environment policy in Brazil) is captured, followed by processing and preparation procedures for distribution and commercialization. The scale fish farming activity has different processes and procedures when compared to the extractive activity. It can be carried out in concrete or vinyl canvas tanks that favor cleaning procedures, water quality control, and pest control. These facilities do not exist in excavated tanks; however, they can reproduce the fish's habitat. The Arapaima gigas production chain comprises a sequence of phases that begins with reproduction. In the second phase, called breeding, the animal grows until the ideal weight for slaughter is reached. These two phases are carried out by actors called "creators," regardless of their size. As with the breeding of other animals, Brazilian fish farming is carried out by large breeders who have farms with dozens of hectares of water, in the same way as it houses small breeders who carry out the activity on their property with the collaboration of the entire family. The processing phase includes slaughtering the animal, eviscerating and cutting activities, and preparing the final product. This phase is connected with the generation of fish waste. The next phase addresses distribution, and in the last phase, commercialization takes place.

According to some estimations, there are more than 800 million people with chronic malnutrition, which could be aggravated by the estimated population increase and other economic and social imbalances (Food and Agriculture Organization, FAO, 2023). Total fisheries and aquaculture production reached a record 214 million tons in 2020, of which 178 million tons were from aquatic animals and 36 million tons from algae, largely due to the growth of aquaculture in Asia, with great emphasis on China (FAO, 2022). Also, according to FAO (2022), the amount of total production intended for

human consumption (excluding algae) in 2020 was 20.2 kg per capita, more than double the average of 9.9 kg per capita found in the decade 1960s, which demonstrates the great evolution and importance of aquaculture in contributing to the challenge of reducing the scenario of hunger and malnutrition in the world. The practical relevance of the topic of externalities in supply chains is evidenced in this information and data and also because chains are complex and prone to failures, which are often perceived by their externalities rather than by those directly involved in the chain (The Economist, 2019).

This paper is organized into five sections. The second section discusses the relationship between externalities and Global Value Chains (GVCs). The third presents the research methodology – while the empirical results of the study are presented, analyzed, and discussed in the fourth section. Discussion and contributions are detailed in this session. The fifth section presents the conclusions, main study limitations, and avenues for future research.

2 LITERATURE REVIEW

2.1 Externalities

The complexity of the chains and the theme of externalities mean that a complete analysis of externalities in GVCs should ultimately apply to the entire value chain and not exclusively to the one lead firm (Buckley & Liesch, 2023). While the concept of externalities has played a key role in economics, global environmental, and human rights for decades, the attraction of public attention is more recent (Libecap, 2014). The list of externalities is extensive, including price imbalance, environmental and social aspects, loss of products that turn into garbage as they are not consumed within the validity period, and situations that generate environmental degradation and contextualize the challenge of growing world demand for food.

The framework proposed by Buckley and Liesch (2023, p.13) points to the

need for having a strong constituency within the GVC (namely the lead firm) that can influence the activities of other members worldwide and effectively change the configuration of the GVC. The analysis of the externalities of the pisciculture production chain guided by management with high levels of awareness, motivation, and capabilities (A-M-C), without which the current situation will not be optimized and will continue to depend on public policies (Buckley & Liesch, 2023). The A-M-C framework proposes the awareness of the externalities, motivations, and capabilities to deal with them. The A-M-C framework, although started in psychology (Buckley & Liesch, 2023), has been used in management extensively in the last 20 years (e.g., see Chell & Allman, 2003) and recently in supply chains and sustainability topics (e.g., Geng, Lam, & Stevenson, 2022; Guo, Li, Liu, & Wu, 2023; Liu, Han, Yao, Gupta, & Laguir, 2023; Riegler, Burton, Scholz., & Melo, 2023; Schniederjans, & Khalajhedayati, 2020).

2.2 Value Chains and Global Value Chains

The emergence of Global Value Chains (GVCs) has been documented in the literature for decades (Gereffi & Korzeniewicz, 1994). The GVC literature highlights the power relations and the distribution of the value generated between the participants in the chain and the world's regions (Gereffi, Humphrey, & Sturgeon, 2005; Gereffi & Lee, 2012). However, more recently, not only the theme of the environment has emerged, but also the growing importance of less developed regions such as Asia (Buckley & Strange, 2015). Little attention has been paid to other actors in the chains (Serdijn, Kolk, & Fransen, 2021) and South America in the GVC literature (Marcato, 2022). The GVC framework has been used to analyze environmental issues (De Marchi & Gereffi, 2023). When the environment is considered, processes of value creation and appropriation have differences in terms of upgrading compared to situations in which only the economic and social aspects of upgrading are taken into account (Krishnan, De Marchi, & Ponte, 2023).

3 METHODOLOGICAL PROCEDURES

The data was collected from different sources, with different data collection procedures resulting from combining different techniques, following the methodological guidelines prescribed by Corbin and Strauss (1990). We opted for a methodological proposal that began with the collection of narrative data obtained from interviews. Each interviewee, a member of the fish farming chain, was asked to describe their activities, commenting on the main difficulties. The same question was then repeated, requesting a panoramic analysis of the chain to identify its bottlenecks from the interviewee's perspective.

The triangulation recommended by Creswell and Creswell (2017) for constructing links in evidence to increase the reliability of information gleaned in the work was implemented through interviews with various actors in the production chain. Thus, 47 in-depth interviews were carried out in individual sessions, the technique of which was able to provide in-depth insight into the topics covered by each agent (Hair Jr., Black, Babin, Anderson, & Tatham, 2014). The sample included fishermen, fish farmers, slaughterhouses, feed manufacturers, traders, fishermen's associations, cooperatives, and community leaders. Experts from research institutes in the Brazilian and Peruvian Amazon and representatives of government agencies were also interviewed.

The research also took on other sources from the literature review that enabled a better understanding of the issue under study (Hair Jr. et al., 2014), in addition to secondary data collected from specialized publications, scientific articles, books, and sectoral reports.

The observation technique was used during visits to companies and street markets and monitoring meetings between governments, the private sector, and fish producers. For Creswell (2010), it is a means to explore and understand the meaning individuals attribute to a social or human problem.

This is, however, a case study where researchers deeply explored the fish farming chain in the Brazilian Amazon region, intending to achieve a clear view of little-known phenomena (Creswell, 2010). Interviewing different links enabled understanding from different perspectives, and the use of in-depth interviews enabled contact with personal accounts and life stories told from the lenses of the interviewees.

The analysis procedure is close to a ground theory, developed in the 1960s by Glaser and Strauss (Godói, Bandeira-De-Mello, & Da Silva, 2017), as we sought to develop a theory about reality investigated based on information and data collected by the researcher, without considering pre-conceived hypotheses (Martins, 2008; Corbin & Strauss, 1990). The collection of data did not have a specific duration; it continued until the researcher determined that they had reached a point of saturation (Egan, 2002).

The conclusions went through a validation process between different actors in the chain to reflect the majority opinion of those involved in the study. With this, we sought to develop a chain of evidence to increase the reliability of the information, as the convergence of results from different sources increases the reliability of the study (Martins, 2006).

4 RESEARCH CONTEXT, PRESENTATION OF RESULTS AND ANALYSES

In this section, we present the context in which the research was developed, then the results in a descriptive manner, and analyze them through the lenses of externalities and Global Value Chains (GVCs) literature.

4.1 Research context

With one-fifth of the planet's freshwater, the Amazon river system has enormous potential for aquaculture and, therefore, plays a prominent role in the global water cycle (Organização do Tratado de Cooperação Amazônica - OTCA, 2004). Due to its geographical conditions, Brazil is one of the few countries that can meet the growing world demand and may become one of the largest fish producers in the

world (FAO, 2012). The sustainable development of aquaculture remains critical to meet the growing demand for aquatic foods (FAO, 2022).

On the other hand, even with all the improvement shown in the period, an integrated action is needed to achieve a more consistent distribution in global consumption in the future since the more developed countries have a per capita consumption of around 25 kg/year, while the less developed countries of 5.4 kg/year, where Brazil is at an intermediate level of 9.5 kg/year.

Currently, fish represents 17% of animal protein consumption in the world (FAO, 2022), in addition to being an important source of vitamins D, A, and B and minerals such as calcium, phosphorus, iodine, zinc, iron, and selenium, especially in selenium. dealing with small species commonly consumed with bones, heads, and viscera. Fish also helps the development of the neural system, reduces the risk of mortality from heart disease, and is particularly important during pregnancy and the first two years of life (FAO, 2014).

Fish consumption should be encouraged, including with a view to food security for low-income populations and children. Regardless of the ratio found between omega-3 and 6, replacing foods high in saturated fat (such as meat and dairy products) with fish is recommended as part of a diet to prevent cardiovascular disease. From an epidemiological point of view, increased fish consumption is associated with lower mortality and cardiovascular morbidity (Scherr, Gagliardi, Miname, & Santos, 2015).

The large amount of protein in fish makes them a fundamental food for weight reduction diets. Fish is rich in proteins and minerals and contains B vitamins and phosphorus; many are rich in omega 3 and 6, natural antioxidants, protecting the premature aging of the veins and restricting cancer cells.

When it comes to the Brazilian Amazon, the region has not only complex challenges such as transportation and social development but also challenges related to trivial issues such as access to the internet. For many specialists, only the attribution of economic value to the standing forest will allow it to compete with other uses that

presuppose its felling or degradation, and only science, technology, and information will be able to show the way how to use the natural heritage without destroying it (Academia Brasileira de Ciências - ABC, 2008, p. 11). Aquatic food systems are a powerful solution to meet the dual challenges of food security and environmental sustainability (FAO, 2022).

Brazil, in the world scenario of marine extractive fishing, does not figure among the 25 most important countries, and in freshwater extractive fishing, it ranks 12th. place, with a participation of about 2% of the world volume (FAO, 2022). Also, according to FAO (2022), in aquaculture, Brazil ranks 8th. world position, which demonstrates an opportunity for more excellent future representation through more relevant participation of the Amazon region, considering that, as previously mentioned, it has about a fifth of the fresh water in the world.

In the context of Brazilian national production, the state of Amazonas ranks 15th. position in producing farmed fish among the 27 entities that make up the Federative Republic of Brazil, quite far from the aquifer potential presented by the region (Peixe BR, 2023).

Among the urgent challenges of the Amazon for the 21st century are the need for new public universities, the creation of scientific-technological institutes, and the strengthening of information networks for the expansion and improvement of broadband technology, in tweak with the isolation and interconnecting educational, scientific and technological centers (ABC, 2008). However, management towards efficiency in processing and adding value to the natural inputs produced in the region is also urgent.

4.2 Presentation of results

In this context, this research focuses on the externalities of the fish farming production chain in the Brazilian Amazon region of two chains: (1) extractive and (2) scale fish farming.

4.2.2 Extractive fish farming chain

In the Amazonian nature, animals live in marginal lakes or large rivers to avoid the current. They usually feed on fish and shrimp but have food flexibility for mollusks, living organisms from the bottom of lakes, and birds or land animals (Halverson, 2013).

The organization of the extractive activity of some species at risk of extinction develops from the capture licenses. The control bodies act in determining the quotas, providing the seals and monitoring the process, being able to intervene in all stages until the commercialization of the final product.

In the early 1960s, Albuquerque (1961) already pointed out the need for modernization, reporting the “incapacity of the evolution of our fishing systems,” which relied on the use of “very old tools” such as the spear, the harpoon, and the harpoon arrow. However, even today, such instruments are used. The capture is carried out by launching a harpoon that pierces the animal. Bringing him closer to the canoe, he receives sledgehammer blows to knock him out. With the animal dominated, the fishermen remove it from the water.

The described method does not provide for prior stunning, nor can it be classified as humane slaughter, which would result in immediate loss of consciousness or induce unconsciousness without discomfort or pain.

After slaughter, as there is no possibility of immediately transferring the slaughtered fish to suitable refrigeration equipment, the fish has to be eviscerated by the lake to avoid the meat putrefaction process. Its viscera are removed, and the fish is washed internally with river water. Once the process is complete, the meat is exposed to room temperature until transferred to ice.

According to situations mapped in this research, fish slaughtered from eight in the morning until noon begin a journey of five or six hours to the refrigerated boat. Fish caught in the afternoon spend the night by the lake to start this journey the next morning. When they arrive at the refrigerated boat, they start a journey of 10 or 15 days to reach the unit.

Geographic limitations and, mainly, the lack of adequate resources and techniques make the evisceration process occur before the fish reaches the slaughterhouse, resulting in another irregular activity from the regulatory point of view of food safety and animal welfare.

Thus, the species created in nature, here called the extractive chain, do not suffer any human influence in reproduction or fattening, feeding naturally on the species available in the rivers. Such conditions make these products preferred by consumers who are averse to industrial breeding practices. However, its meat may be of lower quality, mainly due to the stress suffered by the animal at the time of slaughter and the precarious conditions of slaughter, handling, and transport from capture to sale to the final consumer.

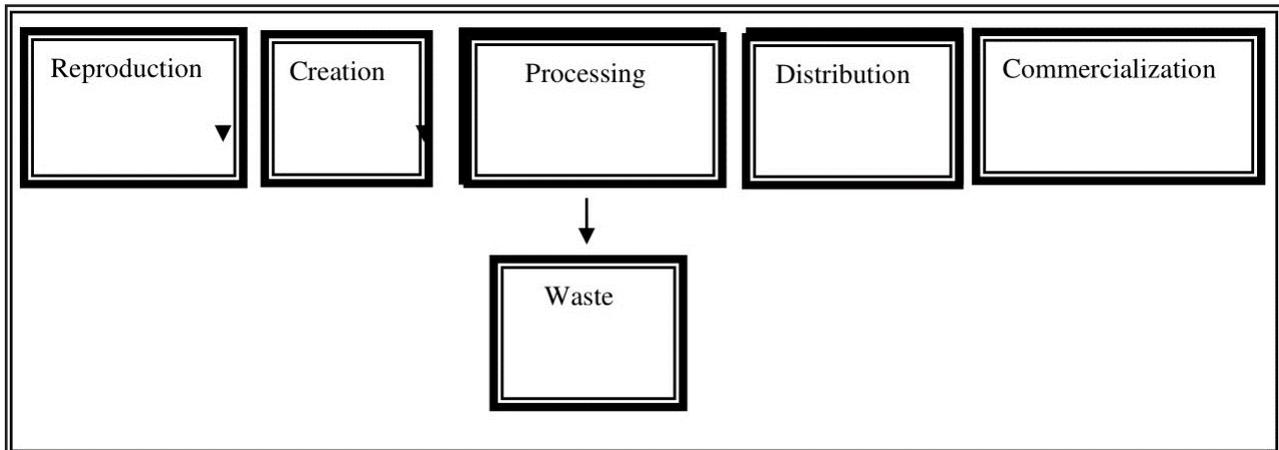
4.2.3 Scale fish farming production chain

Fish farming can be carried out in concrete or canvas-vinyl tanks that favor cleaning procedures, water quality control, and pest control. In the excavated tanks, there are no such facilities. However, they can reproduce the fish's habitat.

The fish farming production chain begins with the animal reproduction stage, followed by breeding activities until the ideal weight for slaughter is reached. The processing phase includes the slaughter of the animal, the evisceration and cutting activities, and the preparation of the final product. This phase is connected with the generation of fish waste. The next phase deals with the distribution, and in the last phase, the commercialization takes place (Figure 1).

Economic viability is directly associated with the use of balanced and high-quality feeds since feeds with a more affordable cost have proven to have less protein and are less palatable. However, data triangulation confirmed that the cost of feed is an impediment to the exercise of adequate management for many species of fish since it represents about 70% of the total production costs.

Figure 1 – Fish farming production chain



Source: Developed by the authors

A few decades ago, the slaughter of animals was considered an operation of a low scientific level until the reflections on the quality of the meat were observed (Vargas, 2011). The behavior of fish suggests that they can feel and are therefore sentient, in addition to demonstrating memory indicators, complex learning reactions such as changing body color during disputes, as well as increased respiratory rate and changes in rhythm and swimming pattern under conditions of fear (Pedrazzani, Molento, Carneiro, & Castilho, 2007). With that, Pedrazzani et al. (2007) state that physical manipulation and harvesting are activities that cause acute physical and psychological stress and should, therefore, be developed only in situations of extreme need.

The logistical difficulties of the Amazon are aggravated by the enormous territorial extension of the region and are even more evident when we deal with the transport of fish, a perishable product that requires low temperatures in a region with a predominantly hot climate.

The precariousness of sanitary conditions and the lack of standardization in post-slaughter handling usually cause the loss of tons of products. Added to this is the deregulation of the sector, which favors the presence of middlemen selling products in communities far from the fishing point, generating unfair competition that goes beyond the proper fiscal and sanitary controls.

Even if such factors were completely corrected, the chain would still have to guarantee consistency in supply, a common condition in contracts with retail chains and restaurants, but a challenge for the chain in question.

4.3 Analysis of results

Awareness-Motivation-Capability (A-M-C, Buckley & Liesch, 2023) example applied in the production chain of large-scale Amazonian fish farming

The awareness of the relationships will come from identifying the other links, getting to know them, and mapping them in their production and location specificities, for example. Therefore, an action aligned with the interests of all links is assumed, in contrast to an individualistic action of a chain with disconnected links. The alignment of interests generates synergy and synchronism, capable of coordinating actions in favor of a slaughter and processing schedule to guarantee the supply of products in different markets consistently.

This is a subject of extreme relevance for the productive chain in question since to access other Brazilian states and/or be exported, the fish must be processed in a slaughterhouse certified by the main government authority (then Ministry of Agriculture, Livestock, and Supply – MAPA, in Portuguese, Ministério da Agricultura, Pesca e Abastecimento). In the Amazon, there is a lack of this type of processing structure. The research identified more beef slaughterhouses, which favor and explain the volume of pastures, than the presence of fish slaughterhouses, which disadvantages and explains the ills of the fish farming production chain and, consequently, the precarious conditions of fishermen locations.

It is not possible to specify the destination of the production. However, it is known that the product subjected to long hours of exposure to the sun has its shelf life reduced, making its commercialization in distant places unfeasible. The organized chain generates an externality with the guarantee of sanitary control and the extension of the shelf life of the product. Such conditions guarantee access to

more distant markets, some demanding more basic animal protein options, others premium products.

With the region producing the raw material, becoming aware of the attributes of the inputs it owns, and starting to add value to them, there will, consequently, be appropriation of the processing and commercialization stages in a process capable of generating beneficial effects with the generation of jobs and income. In the same way, governments increase their collections and perceive relief in social assistance programs.

The motivation to act may come from the interest in meeting the demand for fish, but other justifications also inspire initiatives for the organization of this chain. In this sense, the potential for using waste is highlighted, generating by-products for the fashion industry since some fish species have resistant leather for processing in tanning activities. In the same way, some scales can supply the cosmetics and pharmaceutical industries.

The processed viscera give rise to oil and fish meal, both ingredients for the feed industry and with the potential to reduce production costs, especially when replacing the imported input. Transformation into biodiesel is also an opportunity, although the best use of these inputs with high protein value can be discussed.

Processing residues can be transformed into nuggets, hamburgers and other foods usually processed with beef or chicken. A few months of partnerships with the scientific community would suffice and many other forms of exploitation would be unveiled.

There is also the purpose of developing the region, recognized for the richness of its biodiversity and so lacking in coordinated actions to add local value with the due guarantee of environmental preservation and social appreciation.

The ability to act depends on the protagonism of agents oriented towards development and value creation. It is up to the link dedicated to vertical integration, designing opportunities, and facing obstacles, always managing externalities. Figure 2 shows how each one of the Buckley and Liesch (2023) framework items, A-M-C, applied to the two *Arapaima Gigas* fish chains.

Figure 2 – A-M-C framework applied to the Arapaima Gigas fish chains

A-M-C framework item	The event in the GVC	Consequences - Recommendations
Awareness	GVC integration	<p>Integrated GVC will be able to organize the processing, with a programmed supply and demand management, including the use of residues.</p> <p>A vertically integrated slaughterhouse organizes processing according to the tank animals' slaughter schedule and market demand.</p>
Motivation	GVC accountability	<p>GVC, recognized by stakeholders, is capable of prioritizing Corporate Social Responsibility, preserving the conditions of other links, and favoring the social externalities of the chain.</p> <p>Costs are reduced by using waste to generate by-products that supply this and other chains.</p>
Capability	GVC leadership	<p>GVC with national coverage can manage the externalities of the chain</p> <p>The leadership is capable of promoting the access of the chain's products to the domestic and foreign markets, meeting local requirements, and controlling externalities.</p>

Source: Elaborated by authors based on Buckley and Liesch's (2023) A-M-C framework

Once firms in the chain are aware (A) of the externalities, they may be able to integrate the chain, organizing the processing and with a programmed supply and demand management, including the use of residues. A vertically integrated

slaughterhouse organizes processing according to the tank animals' slaughter schedule and market demand. These actions may drive productivity and competitiveness upwards. Firms that are motivated (M) to address GVC externalities, become recognized by stakeholders, are capable of prioritizing Corporate Social Responsibility actions, preserving other links conditions, and favoring the social externalities of the chain. Costs are reduced by using waste to generate by-products that supply their and other chains. Here, we may see another boost in the productivity and competitiveness of the firms in the chain. Regarding the capability (C) of firms in GVCs to self-correct imperfections by strategy changes and to attend to negative externalities (Buckley & Liesch, 2023), GVCs with national coverage can manage the externalities of the chain and the leadership of the chain by the firms is capable of promoting the access of the chain's products to the domestic and foreign markets, meeting local requirements, and controlling externalities. These results confirm De Marchi and Gereffi's (2023) conclusions that there is a need for details on how firms might effectively reduce their environmental impacts.

Each GVC is characterized by its unique power dynamics (Ponte, 2021). The power dynamics of each chain has implications that are varied and often simultaneous for different groups of actors in the value chain. These implications and effects may surpass the GVC (Krishnan et al., 2023). In the case of the two studied chains – extractive and fish farming - this idea of uniqueness is confirmed as they comprise firms with distinct profiles. In the extractive one, located in the state of Rondonia, with small businesses or communities and individuals working in an activity that can be eventually classified as quasi-subsistence, their position in the chain, regarding governance, is more fragile than the firms in the fish farming chain. In the latter case, besides firms being larger than those in the extractive chain, as they are frequently vertically integrated forward with their slaughterhouses, their position regarding governance is stronger than the firms, communities, and individuals in the extractive chain. However, this vertical integration strategy also has externalities, as these vertically integrated farmers, in

turn, have a stronger hand negotiating with their backward links, notably the other farmers that sell to them. This form of coordination and its negative externalities have been known in the literature for a while (Ponte & Gibbon, 2005).

5 CONCLUSIONS

This study aimed to (i) identify externalities in the chain and (ii) recommend strategies to firms to mitigate and/or avoid negative externalities. With these objectives in mind, we used the context of two fishing chains in the Amazon region in Brazil to answer the research question and achieve the goals of this article. The fish is the *Arapaima Gigas*, and each one of the chains has particular characteristics.

It has been proven that the lack of a properly organized production chain can cause serious damage to certain links. At the same time, other members take advantage of opportunistic actions to increase their profit margins. Likewise, the lack of a holistic approach to the production chain prevents value generation in the region. Thus, in short, some of the externalities generated by the mentioned absence are lower prices than they could be otherwise, environmental consequences, and the perpetuation of social issues in the region.

Regarding strategies for firms to mitigate and/or avoid externalities, actors should not consider only its success. Rather, they should have a more systemic view. This idea has been in the literature for a while (Helfat & Raubitschek, 2000) and seems still in vogue (Coppola, Vollero, & Siano, 2023; Royer & Simon, 2023). The fact is that the fish farming production chain within the scope of this study does not present the integration described by Taylor (2005) and Simchi-Levi, Kaminsky and Simchi-Levi (2009). The prejudice of farmers who have fish in tanks at the point of slaughter, without the possibility of doing so due to the lack or unavailability of refrigerators in the Amazon region, reinforces the guidelines of Chopra and Meindl (2015) on the evaluation of the success of a chain, saying that the analysis should not consider the success of an individual link. The chain will not be competitive, with just a few links accumulating good results.

As predicted by Porter (2004), it was found that vertical integration is favorable for managing the chain's externalities and resulting benefits. However, the research suggests that this model be monitored to guarantee local development with access opportunities for fishermen and small-scale farmers. Likewise, more incentive actions are strongly recommended to increase competition in all links, favoring the emergence of new breeders, slaughterhouses, waste processors, traders, restaurants, etc.

The scenario found in the field research points to the lack of refrigeration facilities in sufficient quantity and capacity in fish-producing regions in the Brazilian Amazon. The recommendations presented in this study also deal with waste for producing by-products and the supply of other production chains.

Corroborating Abramovay (2011), an economic fabric capable of making natural wealth a development factor was not constituted in the Amazon. Priority, the scientific production associated with the chain covers specific links, without the integrative perspective, indispensable for developing its competitiveness. With this, there is a lack of research with systemic analysis necessary for the development of the competitiveness of the production chain, from the initial links to the distribution and commercialization that make up the final stages.

Still, in scientific research, the interviews showed that the results achieved are commonly shared; however, the sharing of adopted techniques occurs only in cases of pre-established partnerships for the development of certain research.

This research allows us to conclude that the lack of adequate organization in the production chain can cause serious financial damage to certain links while other members act opportunistically to increase their profit margins. The absence of a complete production chain also prevents the region from benefiting from added value and all the resulting benefits, such as income generation, increased tax collection, construction and visibility of an Amazonian brand, and the possibility of exporting, among others.

From an academic point of view, the objective of presenting a portrait of two productive chains of Amazonian fish farming was achieved, with an indication of

externalities and forms of mitigation. From a practical point of view, it is expected that this study will serve as a guide for public policies and new investments in links that are notably insufficient from an operational point of view.

The limitations of this study are related to the method adopted and the volume of interviews carried out. Thus, as in case studies, the results cannot be generalized. As a suggestion for future studies, the replication of the method in other production chains is suggested to confirm a protocol for mapping and analysis of production chains from the perspective of each link, covering them completely for a complete and detailed analysis.

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2. Development of hypotheses or research questions (empirical studies)	√	√	
3. Development of theoretical propositions (theoretical work)	√	√	
4. Theoretical foundation / Literature review	√	√	
5. Definition of methodological procedures	√		√
6. Data collection	√		
7. Statistical analysis	√	√	
8. Analysis and interpretation of data	√	√	√
9. Critical revision of the manuscript	√		√
10. Manuscript writing	√	√	

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