Characteristics and Analyses of Strategic Factors in Reverse Channels of Açaí Pulp Production Waste in the Municipality of Castanhal/PA

Caracterização e análise de fatores estratégicos nos canais reversos do resíduo da produção de polpa de açaí no município de Castanhal-PA

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ABSTRACT
When disposed of inappropriately, waste from the production of açaí pulp, originating from the açaí production chain, is the cause of many environmental, economic, and social problems. In an attempt to minimize impact, Reverse Logistics is an instrument of economic, environmental, and social development characterized by actions aimed at the treatment and reuse of waste, which is managed and moved through Reverse Channels. Consulted bibliography defines Strategic Factors capable of promoting the structuring and organization of waste for environmentally appropriate destination by different production sectors. This research analyzed economic, environmental/ecological, technological, logistical, and legislative strategic factors of the reverse channels for açaí production waste in the city of Castanhal/PA, as this municipality's açaí pulp production is nationally relevant. For this purpose, it was necessary first to characterize local reverse channels, since bibliographic and documentary research did not yield relevant information on the subject. Field research—consisting of *in loco* observation, structured interviews, and application of online questionnaires to agents directly and indirectly involved—was fundamental to characterize the object of this study. As a result, we achieved the characterization of reverse channels, as well as their logistical resources and the stakeholders involved, starting from the generation of waste through to transportation and final destination, ending our analysis with the main forms of waste revaluation. Our research also allowed the identification and analysis of strategic factors capable of influencing the structuring and maintenance of activities in this reverse chain.

Keywords: Reverse Logistics. Reverse Channels. Strategic Factors. Reverse Channel Organization. Açaí Pulp Production Chain.

RESUMO
Os resíduos da produção de polpa do açaí, oriundos da cadeia produtiva do açaí, são causadores de diversos problemas ambientais, econômicos e sociais, quando destinados de maneira inadequada. Como oportunidade na tentativa de minimizar tais impactos a Logística Reversa constitui um instrumento de desenvolvimento econômico e social, caracterizado por ações voltadas para que esses resíduos sejam tratados ou reaproveitados. A gestão e movimentação desses resíduos ocorre através de Canais Reversos. A bibliografia consultada define Fatores Estratégicos capazes de promover a estruturação e organização para diferentes setores produtivos. Nesta pesquisa, foram analisadas cinco categorias desses fatores estratégicos: econômico, ambiental/ecológico, tecnológico, logístico e legislativo, existentes nos canais reversos dos resíduos da produção do açaí na cidade de Castanhal-PA, em virtude deste município ter uma produção de polpa de Açaí relevante no cenário nacional. Para tanto, foi necessário primeiramente a caracterização desses canais reversos no município, pois as pesquisas bibliográfica e documental não apresentam informações relevantes sobre o tema. Assim, uma pesquisa de campo, constituída por visitas in loco, entrevistas estruturadas e questionários online com os agentes envolvidos direta e indiretamente, foi fundamental para a caracterização do objeto deste estudo. Um dos resultados obtidos foi a caracterização dos canais reversos, bem como seus recursos logísticos, os stakeholders envolvidos, desde a geração dos resíduos, passando pelo transporte e destinação final, findando a análise nas principais formas de revalorização desses resíduos. A pesquisa também permitiu a identificação e análise dos fatores estratégicos capazes de influenciar na estruturação e manutenção das atividades na cadeia reversa estudada.

Palavras-chave: Logística Reversa. Canais Reversos. Fatores Estratégicos. Organização dos Canais Reversos. Cadeia Produtiva da Polpa do Açaí.

1 INITIAL CONSIDERATIONS

According to the Ministry of Agriculture, Livestock and Supply (MAPA, 2015), since the mid-1990s, demand for açaí pulp has been increasing both in national and international markets. Pará (2016) informs that, in 2014, the production of açaí in the State was estimated at around 900 thousand tons of fruit, generating about 1 billion reais and benefiting several producers in this sector, who use the fruit for pulp manufacture. However, similar to other production chains, the exploration of açaí results in waste generation at different stages, such as extracting the pulp (DIAS *et al.*, 2018). After processing, 15% of the fruit yields pulp and 85% constitutes waste (fibers and stones) (SAGRI, 2010). According to Tavares and Homma (2015), in 2014, the municipalities of Castanhal and Belém—considered the largest pulp producers—yielded more than 30,000 tons (t) of pulp and, with that, more than 170,000 t of waste.

As a means of minimizing impact, Reverse Logistics (RL) stands out—which, according to Leite (2003), refers to the area of business logistics that plans, operates, and controls the flow and the corresponding logistical information of the return of post-sales and post-consumption goods to the business cycle or to the production cycle, through Reverse Channels (RC), adding different kinds of value. In the literature, we find drivers for the implementation of RL programs, often called Strategic Drivers or Strategic Factors (SF). The implementation of organized programs for the return of products and/or for the destination of waste would be due to economic, ecological, technological, or logistical interests, or would have the purpose of complying with effective legislation (LEITE, 2012). It should be noted that, in Brazil, compliance with legal requirements is clearly established through Law no. 12,305/10, the National Solid Waste Policy (NSWP) (OLIVEIRA *et. al*, 2020 and OLIVEIRA *et. al*, 2021).

Bibliographic research did not uncover a detailed discussion about RC in the açaí pulp production chain related to waste. However, the existence of these channels is observed according to Nascimento *et. al.* (2018), and Dias *et. al.* (2018), who described the RL of this waste in Castanhal and Belém, respectively. Despite its importance, there is no specific discussion within literature on how these RC are structured in the açaí pulp production chain from the point of view of SF. Thus, our study sought to characterize

how these factors are present in the RC of waste from the production of açaí pulp or wine (APPW) in the municipality of Castanhal, PA.

2 THEORETICAL REFERENCE

2.1 REVERSE LOGISTICS AND REVERSE CHANNELS

The concept of Reverse Logistics (RL) has continued to evolve, due to the new business possibilities it represents. For this reason, there is a growing business interest in the area, in view of its potential economic and environmental benefits (LEITE, 2002). According to Zucatto and Conceição (2016), research interest on the topic gained strength in the 2000s. In Brazil, as reported by Leite and Brito (2005 *apud* ZUCATTO and CONCEIÇÃO, 2016), academic production on RL has increased since 2002, proving a better understanding of the theme, as well as the implementation of programs in companies, which resulted in improvements for reverse channels (RC) and, on the other hand, made it possible to confirm the lack of data sources with regard to both scientific and business issues.

More broadly, Leite (2003) defines RL as:

> [...] the area of Business Logistics that plans, operates, and controls the flow and the corresponding logistical information of the return of post-sales and post-consumption goods to the business cycle or to the production cycle, through Reverse Distribution Channels, adding different kinds of value: economic, ecological, legal, logistic, corporate image, among others.

In this rationale, RL supports efforts to minimize impacts on the environment, through better management of reverse flows. We can thus note the growing importance of reverse flows, in the sense of returning materials to the production cycle. These flows occur through RCs, and the structuring of RCs takes place with different motivating aspects.

As such, RL is conceived of in two major areas—one in which the products that reached the market return without having been used (post-sales); and another in which products that have been used somehow return or should return, and industrial waste in general (post-consumption)—, including the types of post-consumption and post-sale reverse flows, with the first type addressing discussions more focused on environmental management, and the second, issues more focused on inventory management and transport issues (COSTA *et al.*, 2014).

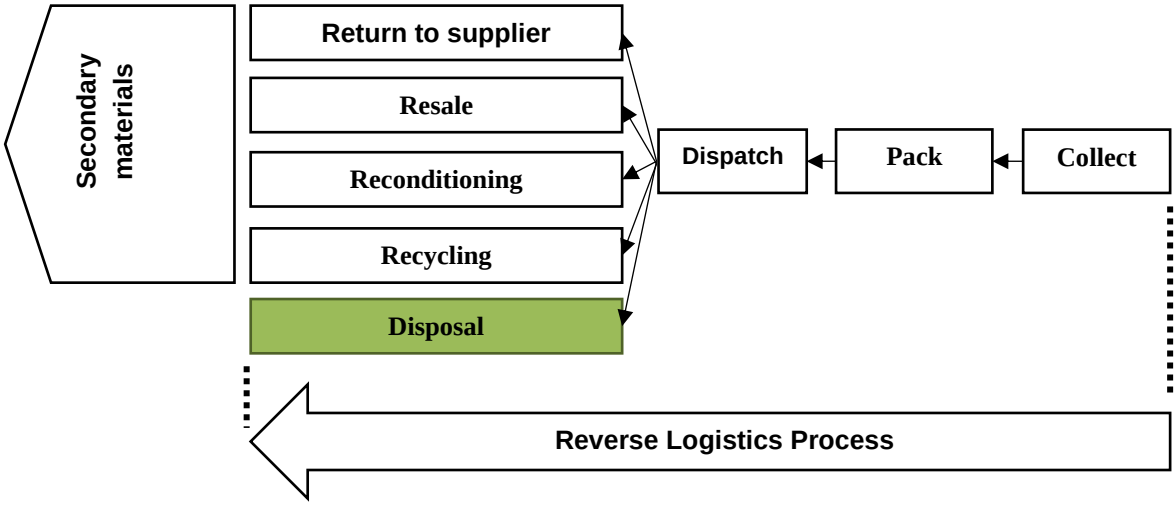
Post-consumption RCs, for Leite (2003), are formed by the reverse flow of a portion of products and constituent materials originated from the disposal of products

after their original use has ended and which somehow return to the production cycle. Within this RC are reverse subsystems: the recycling, dismantling or reuse RCs (LEITE 2003). Portions of these products or of their constituent materials, from now on referred to in this paper as waste, may receive safe or controlled final disposal, which does not cause pollution, or unsafe disposal, which generates negative impacts on the environment (FULLER AND ALLEN, 1995 *apud* LEITE, 2000).

For this reverse flow to happen, we need a logistical equation of return; i.e., it is necessary to carry out a series of procedures—such as collection, transportation, storage—and to define what given market will receive the waste. The type of waste reprocessing or destination depends on its stage in the RL process and on its general condition (COSTA *et al.*, 2014).

Reverse flows can take place for different purposes and be the result of different motivating factors. Therefore, waste can be directed through different return paths—it can return to its supplier; undergo resale, reconditioning, or recycling processes; or, still, be discarded in final destinations such as sanitary landfills or incinerators. In Figure 1 we illustrate the overall RL process.

Figure 1 – Reverse logistics process. Source: Adapted from Lacerda (2002).



As shown in Figure 1, some products naturally return to the production cycle. This occurs when the product has a certain added value, and this value economically compensates for its return. A few studies present the case, for example, of aluminum cans (LEITE, 2003; HADDAD and FREDDO, 2006), whose great value causes the system itself to be financially compensated in all stages.

2.2 STRATEGIC FACTORS IN RC STRUCTURING

The model proposed by Leite (2003) highlights four essential conditions for establishing a RC structure:

- **Financial compensation for all parties** establishes that profitability throughout the RC must economically satisfy all agents, with aggregated costs at a sale price lower than that of the recycled materials or compatible with the raw materials to be replaced;
- **Quality of recycled materials** means that product selected for reintegration into the production cycle must be quality recycled materials which provide compatible returns in the process. Collection and processing have a direct influence on quality due to possible contamination that can render recycling unfeasible;
- **Economic scale of activity** is the main difficulty in establishing a RC. It refers to the supply of post-consumption goods in enough quantity to guarantee activity on an economic and business scale. According to Xavier and Corrêa (2013), the collection of low volumes requires investment in storage and can render both transportation and processing unfeasible, if a minimum viable scale is not reached;
- **Market for products with recycled materials** means that there must be, quantitatively and qualitatively, a market for recycled materials. Most materials have technological restrictions for processing, so that the secondary material has adequate proportions for use depending final product application.

2.2.1 Required Factors for RC Structuring

According to Leite (2003), required factors influence the organization of a RC in different ways, either due to the intensity and precedence of one over the other, or to their performance. These required factors are (LEITE, 2003):

- **Logistical factors** refer to the conditions of local organization and transportation between the links in the RC, and have great importance especially for post-consumption efficiency;
- **Economic factors** are favorable conditions that allow the necessary economy for the reintegration of secondary inputs into the recycled production cycle. According to Fragoso *et al.* (2014), the use of açaí stone, as an energy source for the production of tiles and bricks, brings more advantageous economic benefits in relation to the previously adopted source, as can be seen in the excerpt:

> Each 1 m^3 of stone produces about 1000 tiles and the release of thermal energy from the burning of the stones for the same tile production takes place in approximately 1 hour. Before using stone as the main energy source, approximately 2 m^3 of firewood was burned for the production of 1000 tiles, and release of the total thermal energy from burning took place in approximately 20 minutes. As such, the substitution of firewood for açaí stone has become economically viable, since, for the same number of tiles produced in the same burning time interval, 1 m^3 of açaí stone is used in comparison to the 6 m^3 of firewood previously consumed.

- **Technological factors** are comprised of several stages that require the availability of technology, such as collection of post-consumption waste, disassembly, separation, recycling, or transformation for reintegration into the cycle. According to Leite (1999), the technical evolution of products has increased recycling costs, which, when added to those not less expensive for collection and transportation, have been presented as the main reason for the low efficiency of this RC worldwide.

2.2.1 Modifying factors for the Structuring of reverse channels

Modifying factors are those which encourage RC organization, as they are related to the reaction to "natural" conditions due to society's ecological sensitivity and incentives from public authorities, as follows (LEITE, 2003):

- **Ecological factors** are initiatives for ecological sensitivity, induced by the government, society, and companies for the intervention, ecological selectivity in the consumption of goods, and environmental responsibility of companies, changing the behavior of RCs with the proper destination of waste. Society's concern with environmental impact and ecological balance affects aspects of the RC, such as the disposal of urban waste, due to its harmful effects; the low percentage of disposable packaging recycling; and products/materials that can be recycled or reused, such as organic waste, which can be transformed into compost (fertilizer) for agricultural use (RODRIGUEZ *et al.*, 2012);
- **Legislative factors** are modifying factors arising from government intervention, as an alternative to reduce government costs, satisfying social pressures, or policies to unlock phases of the reverse process, to improve their performance, thus explaining the current cases of implementation of RL by many companies. An important driver of RL is the Legislative branch; for instance, computer manufacturers feel obliged to properly dispose of their products either as a way of preventing future new legislation on the subject or of being able to export to locations in Europe. Consequently, recycling companies are benefited, as they are responsible for providing this type of legal adequacy service (LEITE, LAVEZ and SOUZA, 2009).

2.3 REVERSE CHANNEL OF AÇAÍ PULP

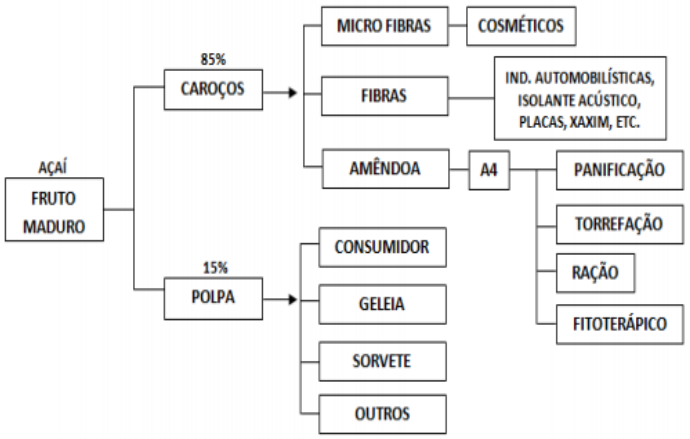
The açaí pulp production RC starts from the depulping stage, when waste is generated. From the moment this waste is generated, it becomes necessary to give it an environmentally appropriate destination. This need gives rise to the RCs, through which all waste will flow and which can serve as economic sources for the generating industries and, at the same time, contribute to the environmental and social sustainability of the region where they were generated.

Law no. 12,305/10, which established the National Solid Waste Policy (NSWP), defines as solid waste generators the "individuals, or legal entities, governed by public or private law, that generate solid waste through their activities, including consumption." Therefore, when generating waste up to reaching the final product (pulp), açaí pulp processing units are characterized as "solid waste generators", more specifically, generators of Açaí Pulp Production Waste (APPW), as stated by law.

It is worth highlighting an important point within the NSWP, which is the shared responsibility for the life cycle of products. Article 10 assigns the Federal District and the municipalities with the integrated management of solid waste generated in their respective territories, and also establishes the generator's responsibility for waste management. Hence, from the law, destination of waste generated from the production of açaí pulp is the responsibility of both artisanal and industrial beaters, which includes adopting practices for the recovery and reuse (e.g., energy generation) of this waste, in its own cycle (closed-cycle RC), in other production cycles (open-cycle RC), or in other environmentally appropriate final disposal.

The stone (endocarp and almond) is the main byproduct of açaí fruit processing—a waste which, according to Nogueira *et al.* (2005), corresponds to 85% of the fruit's total weight. Other byproducts such as sludge can be used, for example, in the production of cosmetics; its fibers, in furniture, acoustic boards, tree fern, plywood, the automobile industry, among others; its clean stones, in the industrialization of A4 products, coffee roasting, baking, edible oil extraction, phytotherapics, and animal feed, as well as in the generation of steam, vegetable charcoal, and organic fertilizer (NOGUEIRA, 2005). Figure 2 shows a flowchart with a few possibilities for recovering value or revaluing APPW.

Figure 2 – Alternatives for recovering the value of APPW. Source: SAGRI (2011).



Due to the açaí stone's high calorific value, another possible environmentally appropriate destination is the use of its biomass as an energy source in gasifiers and boilers for the generation of steam, electricity, and fuel gas—a good technological alternative to generate energy more economically, in view of reduced production costs (SILVA *et al.*, 2004).

3 RESEARCH METHOD

The municipality of Castanhal, PA has made a large contribution to the process of generating APPW in the state of Pará, which steered our decision of conducting research in this region. To investigate and analyze the motivating SFs of RC organization, some tools were needed. In addition to conducting documentary research in specialized literature, we also researched documents from official agencies and news reports related to the subject.

For expanding information on the APPW RCs, we opted for on-site observations, especially to identify sale points of artisanal açaí and, subsequently, to apply questionnaires for both small beaters (SP) and large fruit processing companies (LP). In the case of LPs, the respondents were appointed by each company.

4 RESULTS AND DISCUSSIONS

Results in this paper arise from the compilation of data from questionnaires and observations during visits. Documentary research along with on-site incursions identified, in the municipality of Castanhal, 111 points of artisanal beaters (SP) and 16 agro-industries (LP) which process açaí pulp, thus accounting for a total of 127 points of waste generation. Visits and positive feedback from questionnaires occurred as follows: for the LPs, 11 submissions were made, of which 07 agreed to participate in the research; as for

the other agro-industries, there was no success in contacting them. Regarding SPs, 57 points were visited in order to apply the questionnaires; 46 were willing to collaborate with the research, 5 did not want to answer and 4 only resold the pulp, so they could not be classified as APPW generators.

4.1 CHARACTERIZATION OF APPW RCS IN CASTANHAL, PA

In addition to mapping generation points, we were also able to characterize the municipality's APPW RCs. Upon analysis, the following agents were identified and characterized:

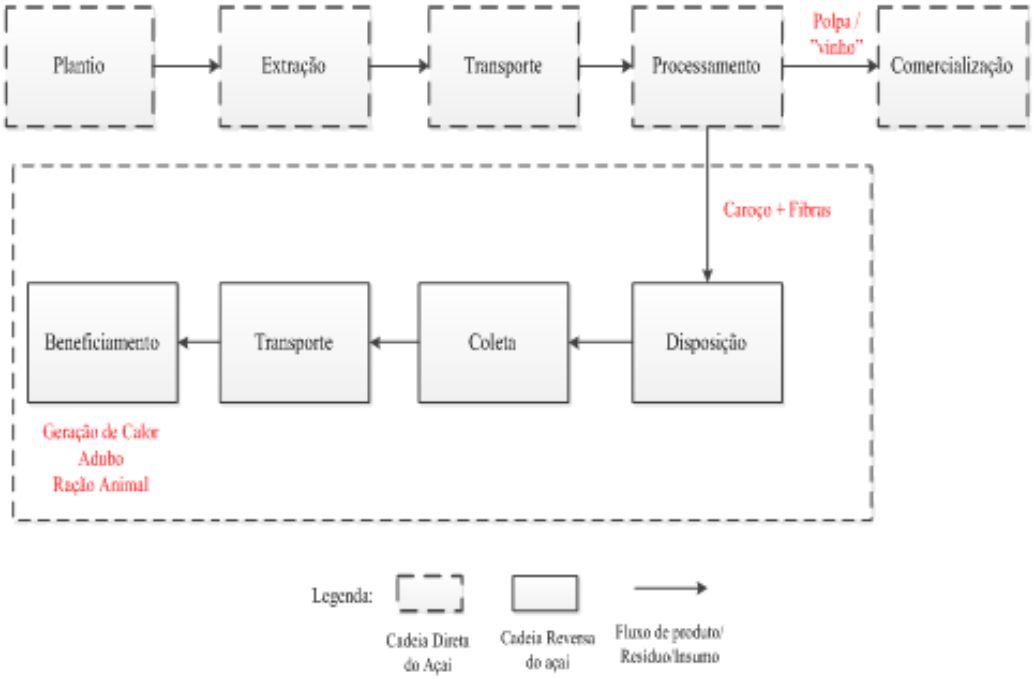
- **Small generator**: artisanal producers of açaí pulp or "wine" that generate APPW in small quantities and discard it in front of the establishment, for collection. The waste is donated to interested autonomous transporters that operate in the region, characterizing an open-cycle RC;
- **Large generator**: açaí pulp agro-industries, which have high production capacity and generate a large amount of APPW. A portion of the waste is used as input, characterizing a closed-cycle RC, and another portion is sold to interested autonomous transporters or to other industries, operating in the municipality itself and/or nearby;
- **Autonomous truck drivers**: they are responsible for collecting and transporting APPW on their own behalf, working with both small (donated waste) and large (sold waste) generators, moving the APPW to their destination;
- **Outsourced truck drivers**: hired by organizations interested in APPW, developing the same activities of autonomous truck drivers, i.e., carrying out the collection and transportation of waste to previously fixed destinations;
- **APPW consumers**: potteries located in the municipalities of São Miguel do Guamá/PA, Inhangapí/PA, and Castanhal/PA; industries producing organic fertilizer in Castanhal/PA and São Miguel do Guamá/PA; and flour production industries, located in Castanhal/PA. They are responsible for the purchase and/or exchange of materials for APPW, carrying out the revaluation of APPW through heat generation or organic fertilizer transformation.

From the interviews with representatives of agro-industries and artisanal beaters, we identified as main forms of APPW revaluation:

- **Heat generation**: carried out in potteries, located in the municipalities of São Miguel do Guamá/PA, Castanhal/PA, and Inhangapí/PA, in order to generate thermal energy from the burning of APPW, used for brick and tile production. It is also used in flour production factories in the municipality of Castanhal/PA, with the same form of revaluation—generating heat to toast the product. This use is also found in one of the seven companies surveyed, namely EP4, which reinserts part of the APPW it generates in the direct production process of açaí pulp, more specifically in the boilers where the pulp is pasteurized. It is worth mentioning that a large amount of APPW is revalued in this manner, with the exception of a single company that did not indicated it as a current destination for this type of waste;
- **Organic fertilizer**: developed by fruit seedling, forestry, and black pepper production companies, among others, located in the municipalities of Castanhal/PA and São Miguel do Guamá/PA;
- **Animal feed**: manufactured by companies that make animal feed, using the açaí stone in their composition, operating in the municipality of Castanhal/PA.

Processes occurring in the RCs were also identified through data collection. In this case, research revealed the following: Disposal, Collection, Transportation, and Processing; see Figure 3.

Figure 3 – Processes for adding value to the RCs of APPW in the municipality of Castanhal. Source: Authors (2017).



Disposal refers to the activity of packaging APPW for later collection. In the case of SPs, it is done with plastic bags or buckets placed in front of the establishments; in the case of LPs, the waste is stored in company silos. Collection is the act of loading the vehicles used for transportation (usually dump trucks). Transportation is usually carried out by trucks, although some LPs use part of the waste as heat source in the pulp pasteurization stage; in this case, transportation occurs internally, with smaller vehicles. APPW is transported to different locations, with potteries in neighboring cities being the main ones, using the waste for heat generation. Processing is usually carried out at the place where the waste is used and depends on its final destination.

In RCs where the processes represented in Figure 3 take place, we identified the agents (stakeholders) directly and indirectly involved. These agents interact with each other and with processes, as shown in Table 1.

Table 1 – Stakeholders in the APPW RCs. Source: Authors (2017).

	Stakeholder (Action)	Positive Aspects	Negative Aspects
Direct	Açaí beaters (Waste generation)	Disposal of material in the vicinity of the establishment for collection, as donation, by truck drivers	Disposal is not standardized; beaters, in general, are unaware of the final destination of the waste, or of the possibility of income from sale
Direct	Açaí pulp factories (Waste generation)	Sale of waste to truck drivers; they use waste as an energy source in the boilers of their own production process	Little information about waste usage, quantity sold, and energy benefit for the boilers
Direct	Truck drivers (Transportation)	Collect waste from small and large producers; negotiate with potteries; some have fixed producers for collection	Amount of waste and price vary during negotiation;
Direct	Potteries (Processing)	Responsible for purchasing waste; some have their own transport for stone collection	Little information about waste usage, quantity bought, and energy benefit for the boilers
Indirect	Public Agencies (Regulation)	Federal Government: establishes the National Solid Waste Policy (NSWP); State Government: establishes the Açaí Quality State Program, decrees, the Açaí Project (use of açaí residue); BIOPARÁ Program	Modest inspection when compared to what is established by law; lack of policies more focused on stimulating the use of waste
Indirect	Pottery Unions (Workers organizer)	Encourages potteries through programs to replace raw materials for energy for açaí stones	Not identified

4.2 STRATEGIC FACTORS IDENTIFIED IN RCS FOR THE LP

The influence of RL SFs, in this research, was classified as positive, negative, or neutral, in relation to the current forms of destination that have been used with APPW generated by agro-industries operating in Castanhal/PA, as follows: 1) Neutral Influence

(Neutral): when the strategic factor is not related to the current form of destination, visible in the participant's reply through the operational aspects that were presented in the study method; 2) Positive Influence (PI): when the strategic factor establishes a relation capable of boosting the form of destination, visible in the participant's reply through the operational aspects that were presented in the study method; 3) Negative Influence (NI): when the strategic factor establishes a relation capable of restricting the form of destination, visible in the participant's reply through the operational aspects that were presented in the study method.

Next, we present our analysis of surveys regarding SF for agro-industries, with relation to RC structuring for APPW.

4.2.1 Strategic Factors Identified in RCs for the LP

Among the SFs related to RC structuring for APPW from LPs, the following characteristics were identified:

Economic Factor: this factor presented a positive influence and some gain in the destination of APPW (although not so economically significant) for 6 out of the 7 companies, with only one of the companies as an exception, where it had a neutral influence. The companies also had expenses with waste storage; only 2 answered that they do not have destination expenses.

Logistic Factor: interviewed companies use silos to facilitate the collection of APPW, where interested parties (outsourced or autonomous) bear the cost of transportation, making the collection on a daily or weekly basis, as established by the company. Waste destinations are Castanhal/PA, São Miguel do Guamá/PA, and Inhangapí/PA.

Environmental Factor: only 2 companies mentioned a positive impact, as they were sensitive to the ecological issue. Other companies, however, indicated the legal aspect as being their only motivator, thus considering this factor a negative or neutral influence.

Technological Factor: it was found to have a positive influence on all companies due to the ease of revaluation and the lack of need for specific technologies in APPW treatment, yielding organic fertilizer, energy, and animal feed, among others.

Legislative Factor: most companies are not familiar with the incentives to revalue APPW, or with the NSWP. Thus, 6 companies expressed feeling obliged by law—whether municipal, state or the NSWP—to give an adequate destination to the APPW.

4.2.2 Strategic Factors Identified in RCs for the SP

We now present survey data regarding SF, in RC structuring for APPW considering SPs.

Economic Factor: we found that this factor is not characterized by profitability via commercialization, since SPs only have costs associated with packaging and no gain with the destination, as the APPW is donated. However, this factor becomes evident with the cost savings in disposing of the waste in suitable locations through autonomous transporters that collect the APPW and deliver it to industries. In this case, the economic factor was considered a positive influence.

Technological Factor: regarding equipment used in the disposal of APPW, the SPs only mentioned equipment related to waste storage and type of transport—bags and trucks—, viewing as neutral the influence of appropriate treatment for reuse, as such a treatment is done solely by consumer industries.

Logistic Factor: characterized by the influence of activities for collection of generated APPW; we have identified activities of storing this residue in bags and placing them in the surroundings of the establishment, where they are collected by autonomous transporters who trade with consumer companies. However, regarding the issue of destination, the logistical factor was characterized as a positive influence, since destinations include companies in the municipality of Castanhal/PA itself or in other nearby regions, such as Inhangapí/PA and São Miguel do Guamá/PA, demonstrating the great importance of location in RC structuring and efficiency.

Environmental Factor: characterized as a factor of neutral influence from what is known by SPs regarding the impacts related to inappropriate destinations. It was identified that the forms of adequate destination would be: a) reuse in any production stage ; b) forwarding to a processing center—since they do not reuse it during pulp production, they forward it to a processing center, the latter being done exclusively by autonomous truck drivers. Concerning impacts related to inappropriate destinations, we identified: a) water pollution (rivers and underground); b) visual pollution; c) bad smell, caused by APPW that remains for a long time accumulated in bags nearby the establishment, exposed to sun and rain, until it is collected.

Legislative Factor: no knowledge on the part of SPs was identified regarding incentives for the revaluation of APPW, such as the NSWP. However, as to proper execution, we found that a few activities were known, such as: a) not mixing waste with any other materials; b) reusing waste for other purposes; c) properly bagging the waste;

d) looking for partners to provide appropriate destination. The legislative factor was characterized as a neutral influence, since the activities are not carried out properly due to the lack of associations and of municipal or government incentives.

From these results, it is clear that none of the SFs had a negative influence—i.e., none hindered RC structuring for APPW identified during the research—, which does not necessarily imply that the current forms of APPW revaluation are the most suitable. With regard to SPs, we identified that the driving factors are related to economic, logistical, and environmental issues, which contribute to the better use of APPW and to the importance given to RC structuring development. The factors that had no influence on RC structuring were the legislative and technological factors.

5 FINAL CONSIDERATIONS

As mentioned, the factors which encourage RC organization and structuring are due to different needs; therefore, our study sought to analyze these SFs in the context of revaluation of Açaí Pulp Production Waste (APPW) in the municipality of Castanhal/PA, in order to propose improvements that could focus on the sustainability of the açaí pulp production chain. As already proven in previous studies, the RC SFs have an influence on waste disposal in general—there being no difference in the APPW RCs, as observed in the development of this field research within the municipality of Castanhal/PA.

Similar behaviors were observed between large producers (LPs) and small producers (SPs), with regard to how they currently dispose of their waste. It can be seen that LPs, companies already established in the market for more than a decade, use their waste mainly for heat generation—as do many newer companies. Through the analysis of economic, ecological, technological, logistical, and legal SFs, it was also possible to observe weaknesses in some aspects of the current APPW RCs in Castanhal/PA that need specific actions, as well as ongoing improvements, considering the reality of the surveyed subjects—especially regarding proper destination of residues, incentives to diversify forms of revaluation, and development of public policies.

For the better reuse of APPW, there is a need to promote actions aimed at positively affecting the three pillars of sustainability: economy (possible reduction of direct and indirect costs related to waste, and direct and indirect gains, such as satisfactory compensation for all agents involved in the RC), society (generating employment and income for those working in RL), and the environment (avoiding possible clogging of the sewage network arising from inadequate disposal of APPW, even reducing the risks of

floods, since APPW, when disposed of inappropriately, can cause problems in the sewage network, increasing surface runoff of rainwater).

As proposals for future work, we can suggest studies aimed at identifying other possible forms of suitable destination for APPW, or possible new links to the composition of the current RC, as well as studies for promoting greater integration between the links of the current APPW RC, enabling better organization in Castanhal/PA and other nearby regions—thus making it possible for the SFs currently identified as not influential in this RC to contribute more effectively to better waste disposal.

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