Food Loss and Waste Valorisation in Agri-Food Supply Chains

The case study of Jerónimo Martins

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Abstract: With globalization and the population growth, consumption and waste of food products has increased exponentially. This increase, combined with the linear model of production and consumption, has become unsustainable for the environment. To deal with the Food Loss and Waste (FLW) issue, combined with the higher society awareness on sustainability, companies have been pushed to become more sustainable. Thus, this dissertation aims to analyse Jerónimo Martins (JM)'s current situation on FLW and suggest possible strategies to improve its sustainability. Therefore, JM, focused on Pingo Doce (PD) supply chain (SC), was thoroughly described and analysed to better understand what measures have been implemented and where most FLW occurs. After concluding that PD stores are responsible for the higher quantities of organic waste, it is suggested three scenarios that can enhance its valorisation. The scenarios provided rely on the possibility of establishing partnerships with valorisation operators, transportation companies and city halls.

Key Words: Agri-food Supply Chain; Sustainability, Food Loss and Waste; Food Valorisation, Jerónimo Martins.

1. Introduction

Globalization gave companies the opportunity of entering in new markets, providing to the customers an improvement in life quality. Nevertheless, such phenomenon leads to higher efforts from the companies to innovate and satisfy its customers (Saath and Fachinello, 2018). With a more globalised world, alongside with the population growth, the resources required to meet demand has increased, which leads to higher environmental impacts (Lopes, 2018).

The Agri-Food sector is no exception to the changes stated previously. Simultaneously, one third of the food produced never reaches consumption (Bagherzadeh, 2014) and one out of ten people in the world is under nourished (World Food Programme, 2017). On the other hand, the food sector is responsible for 8% of the greenhouse gases (GHG) emissions and 1055 billion dollars' worth of misused costs (FAO, 2016).

ONU outlined 17 sustainable development goals to reach a more sustainable society, where the target 12.3 intends to halve the FLW per capita until 2030. FLW is one of the prioritized issues in the Plan of Action Towards Circular Economy, which aims in minimizing the use of virgin resources in production and processing of food products, contributing as well for the reduction of products destined to landfill (European Commission, 2015)..

In this context, Jerónimo Martins intends to improve its operation so that the goals established towards the reduction of FLW are accomplished. JM intends to halve its FLW generation until 2025 (JM, 2019), therefore the study is focused on the organic waste generated in the PD stores, since it is where most of the organic waste occurs.

This dissertation is focussed on providing suggestions to Group Jerónimo Martins on valorisation options for PD stores. With a relative low percentage of stores that separate and valorise its organic waste, this dissertation develops different scenarios that enhances PD stores to start implementing processes and partnerships that allow them to do so.

It is described the methodology used for the development of this paper, following the main steps that led to the strategies suggested on dealing with the FLW generated in PD stores

To reach this goal, the study is structured as follows: In section 2, the literature review focuses in

the characterization of an AFSC and how sustainability influences its operation, but also how collaborative measures prevent FLW. It also explores the main causes that lead to FLW and the main destination methods used. In section 3, it is developed a study on the biggest AFSC leaders worldwide to obtain an empirical view of this issue. In section 4, Group JM is presented thoroughly, where it is described the main processes and direct activities of PD stores' supply chain. It is also described how JM and its suppliers prevent and valorise FLW. Concludes with an analysis on the partnerships in place to deal with the organic waste generated in store. In section 5, it is presented the strategies suggested, which are based on establishing partnerships with valorisation operators. In section 7, it is presented the main conclusions of the study, as well as its limitations. Suggestions for future work that complement the work developed are also proposed to help JM, in case the study is accepted and implemented by the company.

The methodology used is a 3-step process:

- gathering the required information to tackle the FLW issue – AFSC characterization, current reality, main causes that lead to FLW and main destinations and valorisation methods. On the other hand, study the biggest AFSCs in the world in terms of goals established and measures implemented to reduce the generation of FLW.
- Presentation of Group Jerónimo Martins and characterization of the respective SC. How the company addresses the FLW issue and determination of hotspots.
- Provide recommendations to JM that improve their operation on terms of FLW.

2. Literature Review

2.1 Agri Food Supply Chain

AFSC is defined as a set of companies that work together to manage a flow of goods and services related with food products to create value to the customers at the lowest cost possible (Folkerts and Koehorst, 1998; Martínez, 2020). In other words, it includes every activity from production to the consumer – "farm to fork" sequence (Pérez Perales et al., 2019).

The main stakeholders are the farmers or agricultural cooperatives, that produce the food; processors who are responsible for process the products adding them value; wholesalers and retailers that are responsible for the distribution of the products; and the consumers who buy the products. Nevertheless, there are indirect stakeholders, such as 3PL that ensure storage, transportation, waste management, amongst others; Financial institutions, NGOs and food associations that aim in guaranteeing an affordable, safe and sustainable supply; Governments regulate the market and stakeholders

However, AFSCs can be divided in two categories – Frozen and Fresh. This division depends on the type of product managed. Different approaches can be implemented due to the different characteristics of the products, such as perishability.

Uncertainty is one of the highest risks in the Agri food sector and is present to every stakeholder, due to price sensitivity and volatility of the market or due to seasonality and soil quality.

Autoregulation, product tracking and guaranteeing reliable supply are some strategies that allow companies to better identify possible risks in the SC.

Companies have been changing their SC towards a more sustainable management, due to the increasing awareness on the conservation of the climate. Nevertheless, sustainable SCs are seen as an opportunity to attract and keep customers, since consumers are becoming more informed and giving sustainability and transparency a significant importance.

To achieve a sustainable SC, it is suggested to change the traditional linear economy to circular economy, where resource usage is minimized by not removing them until these have no value for any stakeholder (European Commission, 2015). This strategy increases resources yield and enhances the preservation of natural resources.

Industrial symbiosis enhances sustainability, since it provides sustainable competitive advantage through partnerships with companies in different sectors through exchange of energy, materials, among others (Costa, 2010).

The AFSC is extremely extractive and wasteful, from land degradation and depletion of natural resource to usage of fossil fuels. The food industry represents 20 to 30% of the GHG emissions worldwide (Garnett et al., 2016).

Sustainability is one of the goals AFSCs intends to achieve. To reach it, there are two important aspects that will be discussed in the next two sections: **Role of collaboration** and identification, reduction, treatment and valorisation of the **FLW** generated.

2.2 Role of collaboration in sustainable Agri Food SCs

Collaboration between stakeholders is a strategy used so that these entities can more efficiently achieve their goals. It results in higher profits than when companies act individually and to minimization of conflicts and misunderstandings.

The process of collaboration is divided in four steps: **planning**, where it is defined the type of relationship between stakeholders; **Forecasting** of demand and supply to reduce bullwhip effect; **execution** of

orders and respective payment; and **performance analysis** to verify if the previous step occurred as planned.

Collaboration allows companies to increase its responsibility of the SC and increase sustainability levels. Conflicts are minimized, since individualistic behaviour is avoided. Share of information between entities is also a benefit that allows companies to become more efficient.

There are 10 main factors that leads to stakeholders to collaborate: **Joint efforts** to overpass potential difficulties in the system; **Shared activities**, which promote transparency and dependency between companies; **Coordination**, which requires governmental or non-governmental participation; **Adaptation** to different planning phase scenarios; **Power** between stakeholders for strategy management; **Trust** so that companies are comfortable to share risks; **Commitment** to be able to establish a long term collaboration; **Stability**, which is related to commitment and trust; **Continuous improvement** for development of processes and management competences; **Collaboration** to support sustainable production and distribution.

Before collaboration, stakeholders analyse its feasibility considering the three pillars of sustainability, considering the aspects the own company most appreciates, such as high revenues in the economic pillar; low levels of residues in the environmental pillar; and support local businesses in the social pillar.

When a company has power over another company, it is verified a power unbalance. In the AFSCs, retailers have more bargaining power than suppliers, which means that retailers have power over suppliers. When this is verified, it is predicted that the FLW generated increases. (Ghosh and Eriksson, 2019).

2.3 Food Loss and Waste in AFSCs

One third of the food production worldwide, 1,3 billion tonnes of food, does not get consumed. This is due a mismanagement of the natural resources, that leads to an environmental impact for society and economic consequences for the businesses (Bagherzadeh et al., 2014). The FLW generated is responsible for 8% of the GHG emitted globally.

Depending on the development stage of a country, the stage in the SC responsible for higher rates of food waste. While developed countries have more waste in the households due to medium/high income, developing countries register production and processing as most responsible due to inadequate technology. The different characteristics between products, such as perishability and seasonality, are also factors to consider when dealing with FLW. Overproduction exploits the soil, increases GHG and enhances depletion of natural resources (Jurgilevich et al., 2016). Production, handling and storage, and consumption are the SC stages that most contribute for FLW.

FLW affects every pillar of sustainability, since it jeopardizes the food availability and respective price, enhances depletion of natural resources and increases costs of production and waste treatment.

FLW awareness has been increasing and studies have been developed towards its prevention and reduction. Nevertheless, studies can have different definitions of the crucial concepts studied, such as food loss and food waste. Therefore, it is important to firstly establish a consensual definition on these concepts.

To better prevent and reduce FLW, it is important to study its main causes. For that, different approaches can be developed, since the stage of the SC, the macro-economic conditions of the country and the power unbalance verified are all factors that can influence the generation of FLW. Considering the SC stage, the main causes are (Lipinski et al., 2013; Bagherzadeh et al., 2014; Cicatiello et al., 2016; FAO, 2018):

- Production – Poor harvesting technology; overproduction; quality standards requirements; infestation; weather.
- Handling and Storage – Pests; fungus; transportation/storage conditions
- Processing and Packaging – Products not fit for processing; defective end-products; processing facilities' conditions.
- Distribution and market – Quality standards requirements; expiration date; damaged products; inappropriate procedures for inventory control and management
- Consumption – Over-purchase; over-cooking; quality standards requirements.

On the other hand, geographic, economic and development situation of the country in question influences where FLW is most likely to occur. While developed countries show higher FLW rate in the downstream stages, the developing countries are more likely to generate FLW in the upstream stages. Globalization enhances dependability and contracts the agricultural sector for the developing countries since more developed countries have more efficient processes allowing them to establish lower prices (Baptista et al., 2012).

Industrialised countries have abundance, readiness and low prices for food products, enhancing consumption and waste.

The causes for FLW can also be divided in **technological**, such as misuse of modern technology; **corporative**, such as inaccurate demand forecast; **institutional**, such as standards on food quality and agricultural policy; and **social**, such as customers' behaviour (Canali, et al., 2016). The relative power between stakeholders can lead to an increase of FLW in the SC, since the powerful entity may not have accountability on the FLW generated, attributing it to the least powerful entity (Cox, 1999).

2.4 Main destinations and valorisation methods for FLW

Depending on the stage of the SC, policies and solution can vary. Nevertheless, prevention of FLW through the increase of processes' efficiency is the best way to reduce FLW's impact on the environment. Avoiding the disposal of food products and keep it in the market, through circular economy and industrial symbiosis reduces FLW in the SC (Bagherzadeh et al., 2014). Biogas and biofuel production are some solutions suggested (Arancon, 2013).

FLW standard (Hanson et al., 2016) and FUSIONS manual (Tostivint et al., 2016) suggest the valorisation destinations almost similarly, which means that it is relatively easy to identify the possible destinations. The prioritisation list (Table 1) of destinations was developed by Champions 12.3 focused in FLW, where the destinations are divided in four groups: A – Prevention and redistribution; B – High valorisation; C – Don't contribute to the target but valorises FLW; D – No valorisation.

Table 1 - Hierarchy of destinations to achieve target 12.3 (Adapted from Hanson, 2017)

Destinations	Description
1. Prevention and redistribution	1.A
2. Animal feed	1.B
3. Biological materials/ biochemical processing	1.B
4. Codigestion/ Anaerobic digestion	2.C
5. Composting/ aerobic digestion	2.C
6. Land application	2.C
Unharvest/ abandon on soil	2.C
Controlled combustion	2.C/D
Landfill	2.D
Sewer/ wastewater treatment	2.D
Rejection/returns/residues	2.D

HENVI Science day also provide policies and solutions for food production, food consumption and food waste and surplus management:

- Food production – Support local farming and recycled nutrients; enhance circular economy; incentive direct sales from farmers to consumers.
- Food consumption – Educate consumers on sustainability; promote sustainable habits; demand higher quality on labelling information; Enhance plant-based diets.
- Food waste and surplus management – Close material loops in the SC through circular economy and industrial symbiosis; revise food standards and legal barriers of donations; Support sustainable businesses;

ENCDA established three strategic targets to fight FLW: prevention through awareness and programmes that educate younger generations; implement a harmonized method in the EU to measure where and how much FLW is being generated and reduced; and monitorization of the entire SC to develop awareness and find hotspots (CNDCA, 2017).

Products from different origin have also different approaches to their valorisation. While **animal-based** products can be used for rendering, use of organic acid, enzymatic protein hydrolysis, among others, **plant-based** products are better valorised when used as source of dietary fiber, food additives or source of protein (Aspevic et al., 2017; Ayala-zayala and González-Aguilar, 2011; Gowe, 2015, Elleuch et al., 2011).

2.5 Centralization VS Decentralization strategy

Risk pooling and risk diversification are two factors analysed for the implementation of a (de)centralized SC. While variance cost are reduced in decentralized facilities (Lawrence and Zuo-Jun, 2006), centralized facilities reduce demand variance. Therefore, it is required an analysis on the market to understand which strategy is better fitted.

Centralized inventory has benefits on warehouse and inventory costs, however transportation can be more costly. Lead time is higher for this strategy increasing uncertainty (Milewski, 2020).

For the food industry, it is costly to have inventory, therefore it is suggested to apply a centralized strategy. Collaboration between stakeholders, such as between wholesalers and transporters is crucial for an effective and efficient distribution (Milewski, 2020).

Specialized transportation operators are preferable for centralized systems, where the company can focus on its core competences, while transporters distribute the products. On the other hand, transporters can assure full truck loads that leads to lower rate of transportation, which reduces transportation costs for the contracting company (Milewski, 2020).

40% of the bio-waste generated in the EU is landfilled (European Commission, 2010). However composting and anaerobic digestion are the two main uprising alternatives to this destination. Nevertheless, these destinations generate heavy vehicles traffic and bio-aerosol, which are harmful for the nearby population (Domingo and Nadal, 2009). Changing to more decentralized and smaller facilities can provide positive outcomes such as:

- Decrease of waste materials stored before valorisation;
- Facility's benefits maximization for the local community;
- Shorter distances – less air pollution, traffic, noise and transportation costs;

However, decentralizing valorisation facilities reduces the amount of waste receives which can hinder their efficiency (Righi S. et al., 2013).

Righi S. et al. (2013) analysed different scenarios of valorisation methods combination and concluded that composting and anaerobic digestion are the best combination to reduce potential global warming, ozone depletion potential, among other factors. However, it is important to minimize distances travelled and have citizen participation.

3. The case of the worldwide AFSC leaders

3.1 Progress towards the goals to reduce FLW

This case study is focused on the AFSCs present in the Top 25 more sustainable companies, according to Gartner. The companies addressed are Nestlé, PepsiCo, Walmart, Coca Cola, Diageo and Starbucks.

This case was developed to have an empirical view of the literature review. Therefore, it is analysed how these companies have reduced their FLW, what are their targets for the following years and the progress accomplished towards the goals.

The analysis takes into account the hierarchy defined by target 12.3.

It is verified that different companies are compromised in achieving similar goals towards a more sustainable operation in terms of FLW, being halving the generation of FLW the most common goal.

4. Case Study

4.1 Jerónimo Martins

Jerónimo Martins is a Portuguese company present in three different markets: Portugal, Poland and Colombia and operates in specialized retail and food retail, where the latter is responsible for 95% of the sales volume (JM, 2021). Pingo Doce is JM's insignia for the food retail sector in Portugal and is responsible for 20,1% of the sales volume of the Group.

4.2 Supply Chain

There are two main flows that food products can follow to reach PD stores (Fig. 1). While the products that are not altered start in the suppliers, then are transported to the distribution centres and then to the PD stores, the products used to produce meals for the Take-Away and Restaurants follow to the Centralized Kitchens instead of the DCs.

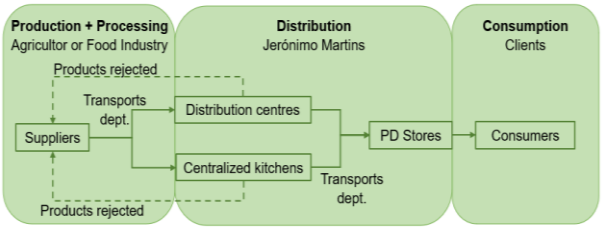

Figure 1 - Generic flow of F&V products in the SC (Fialho, 2020)

PD's supply chain is divided in three regions: North, Centre and South, where each region has its own DC and it is responsible for the distribution of the food products to the stores within the region. Depending on the product, DC must be kept at a certain temperature and the inventory strategy can differ. Focusing on the F&V warehouse, the facility must be kept at a temperature in the range between 6ºC and 12ºC. Due to the perishability of these products, it is applied a Just In Time (JIT) strategy, where the products arrive and leave the DC in the same day. This strategy contributes to lower amounts of FLW generated.

Nevertheless, the reception of the products in the DC is very important for the FLW reality for JM. In this phase, JM becomes responsible for the FLW generated, thus it has to guarantee that the products received fulfil the required specification to be fit for sale.

4.3 Food Loss and Waste

To address the FLW issue, JM measures and reports its generation through the Food Loss and Waste Protocol (JM, 2021). According to this methodology, JM's generation of FLW has been constantly increasing, reaching 16,9 Kg/ Ton of food sold in 2020. This is justified by the increase of F&V

and Pastry/Bakery products which are very perishable (JM, 2019).
In fact, in the stores, the specialized perishables are responsible for 71% of the FLW generated, where F&V represent 48% and Pastry/Bakery represent 22%.

4.4 Processes for Prevention and Valorisation of FLW

In terms of valorisation of the FLW generated, JM tries to follow the valuation hierarchy previously presented. Currently, animal feed and biomaterial represent 15% of the valorisation methods, while controlled combustion, anaerobic digestion and composting represent 61%; at last, landfill and sewage represent 24% (JM, 2021). Nevertheless, before sending the FLW to valorisation, it is analysed the possibility of donating the products. PD registers an average of 12% of the products that not fit for sale are destined to donation, where Pastry/ Bakery (47,2%) and Dairy products (41,8%) are the products category that have higher rate of donation.
For the upstream stages, according to one of the largest F&V supplier, Estevão Luís Salvador, the measures implemented are as follows:

- Investment in infrastructure – Build refrigerated storage to adequately storage F&V products for longer periods of time.
- Improve techniques – Invest in technical information that can provide information on what to plant; at what time of the year; in what quantities…
- Reprocess FLW – Suppliers receive inputs, where part fulfil JM's requirements and are sent to PD stores. Although part of these inputs does not fulfil the specifications and can be valorised before sending it to the destinations previously mentioned to valorise FLW. Some destinations used to avoid sending the inputs to valorisation facilities are: process F&V to obtain 4th range products; send the products to the centralized kitchens; Soups and Juices; and Secondary market, where the inputs can be sold to other retailers or to companies such as JMA where it will be used as animal feed. These alternatives are more attractive to suppliers because they have financial return.

On the other hand, PD stores implement the following measures:

- Educate employees – Training employees to handle and adequately analyse the products
- Develop products – Allow customers to taste the product in store to enhance sales in "ugly" food. Create "Atelier da fruta" to donate products with flaws, after removing the bad parts.
- Investment in infrastructure – Create circular expositors to provide equal access to every product, thus reducing risk of damage.
- Review promotion policies – Markdown strategy, where products close to the expiration date are put in discount. This measure has avoided 4.700 tonnes of products going to waste, in 2020 (JM, 2021).

It is required to have a detailed inventory control to effectively implement these measures. Nevertheless, others strategies are implemented to avoid the generation of FLW, such as portions adjustment; cutting large fruits; reprocessing bread leftovers to introduce them in meals; sandwiches with chicken and piglet leftovers; and creation of the book "Zero Waste at the Table" (JM, 2021).

4.5 Valorisation Operators

PD stores register rates of valorisation significantly lower than Biedronka, mostly justified by the Poland's acting legislation that enhances alternative destinations rather than landfill. PD registers 65,2% of overall valorisation rate of the waste generated in stores.
As can be seen in Fig. 2, PD has low rate of collection of organic waste (33,8% of PD stores), and it is mostly concentrated in city centres. The present partnerships in place are with local city halls and Blue Otter. The stores with no partnerships allocate the organic waste to the indiferentiated bin, and for both scenarios, the valorisation method utilized for the waste collected is responsibility of the valorisation operator and depends on the composition of the waste.

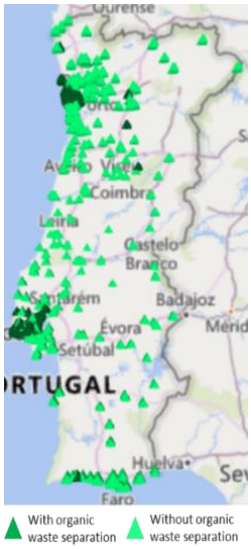

Figure 2 - Map of PD stores

5. Partnerships with Valorisation Operators

5.1 Improvement of Today's Partnerships

The lack of infrastructural conditions to store the organic waste for its collection is the main obstacle for the stores located in **Lisbon** to start separating

its organic waste. To deal with such issue, it is recommended to (i) rearrange the partnerships' contracts to include certain stores in the collection route, when this is done daily or to (ii) centralize the waste generated in these PD stores in stores that have the conditions to separate the waste and already have a partnership in place. Expanding Blue Otter's responsibility to PD stores located in Setúbal is also suggested. An optimization on the partnerships of PD stores located in Lisbon leads to an increase of 1,6%.

On the Other hand, **Porto** has every store already separating its organic waste. The collection service is provided by the city hall and transports the waste to Suldouro.

In **Algarve**, it is suggested to increase the number of stores allocated to Blue Otter or to contact local city halls to provide the collection and transportation to Algar's valorisation facility. A partnership that includes every store of Algarve would result in an increase of 6,1% PD stores separating and valorising its organic waste.

At last, it is suggested to analyse which **city halls** have valorisation operators nearby so that partnerships with local city halls can take place to collect and transport the organic waste generated in those stores. It can also be considered other institutions, such as hospitals or schools, to receive the products that are not fit for sale but are safe.

5.2 New Partnerships

Environmental Global Facilities (EGF) was the first valorisation operator suggested. This company is composed by 11 subsidiaries across Portugal, reaching 174 counties and 6.2 million habitants. Some subsidiaries are the destination of the partnerships described above, however there are other subsidiaries that are not partnered with JM. This company has handled 84 million tonnes of organic waste, in 2020.

If JM partners with every subsidiary of this company, it would result in having 76,5% of PD stores separating and valorising its organic waste, which means that would be verified an increase of 142% of organic waste valorised.

Nevertheless, there are subsidiaries, such as Valorsul, that are already receiving organic waste from the stores, although it still has many stores within its operation area that are not separating the organic waste for valorisation. In this scenario, it is suggested to contact the local city halls to analyse the possibility of having this type of residues collected and sent to valorisation. If the city halls do not have the required capacity to provide such service, it is recommended to contact a private transportation company.

EGF also has valorisation facilities for other types of residues, such as plastic and paper, which means that this company can not only deal with the organic waste, but also the other residues generated in the PD stores.

This company provides mechanical and biological treatment and energy recovery for the received residues.

In fact, in 2024, separating organic waste will be mandatory. Thus, JM will have to improve the storage conditions of these stores or it will have to celebrate contracts with city halls/ transportation companies/ valorisation operators to provide daily collection so that large quantities are never achieved.

The subsidiaries that will provide a bigger improvement are Amarsul, Algar, Ersuc and Resinorte, with each one increasing more than 5% of PD stores valorising its organic waste.

The **Associação de Municípios da Região do Planalto Beirão** is the second valorisation operator suggested. This company is responsible for the collection, transportation and valorisation of the urban residues of Coimbra, Viseu and Guarda districts. Every PD store located in these districts is included in the operation area of this company. Since EGF has no subsidiary located in this area, a partnership with this association would be a good opportunity for JM. This valorisation operator operates in an area capable of including the organic waste of 2,8% of the PD stores.

The mains valorisation methods are anaerobic digestion and composting.

Ambitrevo is the last valorisation operator suggested. This company is located in Coruche and receive residues from agri-food industry and organic products unfit for consumption. The transportation and valorisation are responsibility of this company. The valorisation methods available are composting and anaerobic digestion.

A partnership with Ambitrevo that would include every PD store in Santarém that still has not a partnership for the collection and valorisation of its organic waste would result in an increase of 3,7% of PD stores valorising its organic waste.

If the partnerships mentioned were to be established, JM would reach 83,1% of PD stores separating and valorising its organic waste.

Fig. 3 represents how much each partnership would contribute for the increase of PD stores separating and valorising organic waste.

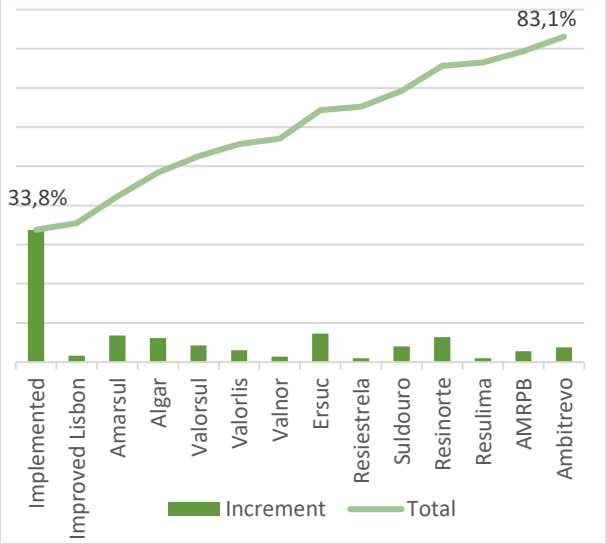

Figure 3 - Increment of PD stores valorising organic waste by partnership

On the other hand, the Fig. 4 shows which areas of Portugal are covered by these partnerships.
As can be seen in the figure, most of the PD stores are included in these partnerships. Nevertheless, there are regions that are not still covered by the partnerships suggested, such as Bragança, Évora and Beja. For the stores located in these areas, it is suggested a centralization strategy.

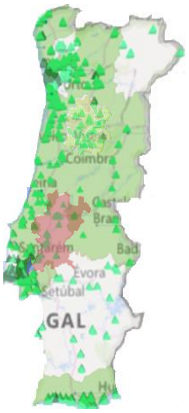

Figure 4 - Map of new partnerships

5.3 Centralization Strategy

It is suggested to implement a centralization strategy for the remaining 16,9% PD stores that are not included in the previous partnerships.
The stores that are located in areas that do not have valorisation operators nearby and do not have sufficient amounts of organic waste to have it collected individually are suggested to take advantage of the benefits of centralization, such as reducing transportation costs.
To implement such strategy, different scenarios can be considered and are as follows:

- Scenario (a) – Stores transship their waste to a store capable of storing the waste, and a partnership with a valorisation operator is established.
- Scenario (b) – Stores transport their waste to a storage facility closer to the most nearby valorisation operator so that the operator can reach this facility.
- Scenario (c) – Direct transportation from the stores to the valorisation operator, having multiple stores included in the route.

These scenarios can occur having transportation provided by local city halls or private transportation companies. The choice between them depends on the availability of the companies, but also distances between locations. The transportation to the valorisation facility has to be provided by private transportation companies or by the valorisation operator, since the facility is located outside of the city hall.
This strategy can also be implemented whenever PD stores within the possible partnerships area mentioned previously are not capable of establishing them.
It can also be considered a partnership with entities in the HORECA channel or with other retailers to achieve full truck loads.
To have a clear overview of the strategies suggested, Figure 5 was developed.

Figure 5 - Overview of partnerships suggested

6. Conclusions

This dissertation emerges from the need to improve JM's reality on how to tackle the issue on FLW. Since FLW is mostly generated in PD stores, it is where the study is focused.
The literature review is firstly developed to understand the current reality on FLW, the main causes that generate such waste and the strategies that are most preferred to prevent and valorise it. It is verified that the collaboration between stakeholders can help the prevention of FLW and overall sustainability.
It was developed a case study on the AFSC leaders, according to Gartner, to have an empirical view of the literature review. In this case study, it is stated the main objectives these companies have established to address the FLW generation, the measures implemented to achieve such goals and how each of the measures implemented have contributed for the progress of these goals.

At last, it is presented the Group JM, with a thorough description of its SC. It is described the processes some stakeholders have implemented to deal with FLW, as well as prevention strategies.
Since it was verified a low number of stores valorising its organic waste, the study aims in finding valorisation operators and possible partnerships that enhance its separation and valorisation. In some cases, centralizing the organic waste in a designated store or facility can also be a feasible solution.
It must be considered the fact that legislation changes in 2024, where PD stores will be obligated to separate its organic waste. Thus, JM should start planning and analysing available possibilities so that PD stores are in compliance with the future legislation.
Apart from the suggestions provided, this study allowed to learn about: the Group JM, the biggest AFSCs and the retail industry; AFSCs' complexity and impact on the environment; strategies to tackle the FLW issue and the valorisation methods most prevent in Portugal;

6.1 Limitations

Despite being considered that the main goals of this study have been achieved, the study had some limitations such as:

- Different sources of information.
- Lack of information on FLW in PD stores.
- Lack of information on valorisation operators.
- Lack of information on costs and duration.

6.2 Suggestions for future work

The priority for future work is to consolidate the strategies suggested with the relevant economic values, such as transportation cost.
On the other hand, JM has to analyse the investment requirements so that PD stores are capable of separating organic waste considering the legislation change.
At last, JM has to consider the availability of valorisation operators, private transportation companies and city halls' transportation companies to the collection, transportation and valorisation process.

7. References

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