

Food Loss and Waste of Fruits and Vegetables in supply chains

The case study of Jerónimo Martins

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Abstract: The evolution of consumption and waste generation has made the current linear model of production and consumption unsustainable. Thus, it is necessary to develop objectives and projects that lead to sustainability. The present dissertation explores this need by studying food loss and waste (FLW) of Fruits and Vegetables (F&V) in Jerónimo Martins' (JM) supply chain, more precisely in its banner Pingo Doce (PD), as it is one of the factors which can largely contribute to the company's sustainability. In this sense, its supply chain is analyzed in order to understand the different stages of the operation and how the stakeholders relate. The study also identifies causes throughout the supply chain for FLW and the respective measures to minimize and value it. The main goal of the dissertation is to develop a Benchmarking methodology for the case study that compares and evaluates the current measures used by the banner PD and the ones used by other successful companies in the food retail industry. After this evaluation, JM is recommended 3 possible scenarios with a different set of measures to be implemented. Each scenario requires a different degree of resource expenditure.

Key Words: Jerónimo Martins; Agro-food Supply Chains; Food Retail; Food Loss and Waste; Fruits and Vegetables; *Benchmarking*.

1. Introduction

The world population has been growing at a rapid pace. This has led consumption to evolve in the opposite direction to the availability of natural resources, being currently 1.6 times greater than its annual regeneration. In addition to the excessive consumption, there is a high generation of waste, namely food. This food waste has a major negative impact such as annual economic losses worldwide, global emissions of greenhouse gases (GHG) and jeopardizing food security (FAO, 2019).

The evolution of consumption and generation of waste requires a change in the direction of sustainability. The linear model of production and consumption is no longer capable of supplying the world population. To deal with this problem, the United Nations (UN) defined the 17 Sustainable Development Goals (SDGs), in which goal 12.3 is to reduce 50% FLW per capita by 2030.

In this context, JM's motivation arises to develop the present study about FLW of F&V in their supply chain. Given the global objectives, JM is committed to reduce 50% of its food waste by 2025, with the year 2016 as reference (JM, 2019). The present study focuses on the F&V flow that goes to PD stores for the following three reasons: (i) PD is the

banner with the highest FLW per store, (ii) Consumption worldwide of F&V is increasing, (iii) F&V are the products with more FLW in PD stores (48%).

The main objective of this work is to develop a Benchmarking methodology for the JM case study that compares and evaluates the current measures of minimization and valorization of F&V used by PD and the ones used by other successful companies in the food retail industry. This concludes with the recommendation of measures to JM.

To achieve this goal, the paper is structured as follows. In section 2, the case study starts with a presentation of the company and then a characterization of its F&V supply chain. Following, there's an analysis of the problem FLW and a description of the current measures used by PD across the supply chain. In section 3, the literature review explores themes related to the JM problem such as: sustainability and circular economy; sustainable supply chain management; FLW and agro-food supply chains. In section 4, there is a literature review regarding Benchmarking, its classifications and different methodologies appropriate to the JM case study. Finally, in section 5, a Benchmarking methodology is applied to the

JM case study. The methodology describes and evaluates the current measures of minimization and valorization of FLW of F&V implemented by companies in the food retail industry, concluding with recommendations for the PD banner. In section 6, the main conclusions about the work are presented, and so are its limitations and suggestions for future developments that may be carried out by the company.

2. Case Study

2.1. Jeronimo Martins

JM is a Portuguese company that operates in the food retail and specialized retail. The first sector represents the main business activity with 95% of sales (JM, 2018). The company is present in 3 different countries: Portugal; Poland and Colombia and each of them has different banners. The banner PD operates in Portugal and has the 2nd biggest market share in the food retail sector, following its main competitor Continente.

2.2. Supply Chain

The supply chain of F&V that includes the PD Stores contains 2 flows of goods (Fig.1). One involves **Suppliers; Distribution Centers; Transports** and **Stores**, while the other, in place of Distribution Centers has **Central Kitchens**. The main difference is the type of product in each flow. In the first, F&V are never altered, while in the second, the Central Kitchens use F&V to prepare meals for the Restaurants and Take-away of the PD stores.

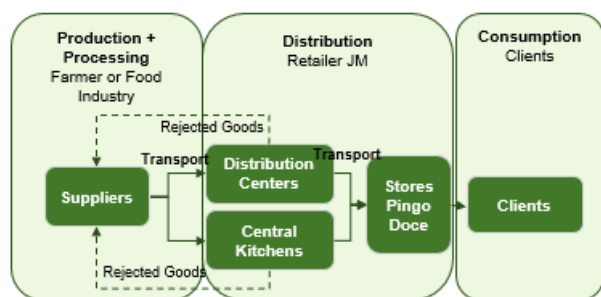


Fig.1 – Stages of supply chain of F&V and respective stakeholders

The supply chain is divided in 3 regions: North; Centre and South. Each region has their Distribution Centre for F&V and is responsible to supply the stores in their area. These warehouses receiving F&V need to be kept at a temperature between 6°C and 12°C and work in a regime Just-in-Time (JIT). This regime is used for perishable products and implies no storage. The product is shipped the same day it is received, contributing to a near zero FLW at this stage of the supply chain.

One critical point in the supply chain for JM is the reception of goods from suppliers. Given from that point on any eventual FLW becomes JM's responsibility, it's of the utmost importance to validate at that stage if the goods meet the retail specifications.

2.3. Food Loss and Waste

Regarding FLW in JM, the company uses the methodology **Food Loss and Waste Protocol** (Hanson, Brian, & Robertson, 2016; JM, 2019) to measure and report it. According to the methodology, FLW produced directly by the JM has been increasing over the years, reaching 15.9 Kg of lost or wasted food / Ton of food sold in 2018, mainly because of an increase in F&V and Bakery/Pastry (JM, 2019). Across the supply chain, we can also identify more FLW of F&V in Suppliers and Stores.

2.4. Processes for Food Loss and Waste

Regarding the measures taken by JM to minimize and value FLW, the company always tries to take into account the FLW valuation hierarchy (EPA, 2018) to choose FLW's destinies. Currently, the distribution is as follows: animal feed + biomaterial (15%); anaerobic digestion + compost + controlled combustion (61%); landfill + sewage (24%) (JM, 2019). Before deciding on the destiny, it is assessed whether the food meets the food safety criteria so it can be donated. Thus, JM has as a priority to give utility to FLW and, if possible, create solutions that allow a financial return.

As for measures taking place upstream JM's supply chain, according to 2 of the largest F&V suppliers Campotec and Estevão Luís Salvador, the following measures are being implemented:

- **Investment in infrastructure** - Building large refrigerated storage, which allows to storage some F&V for annual periods (eg apples).
- **Improve techniques** - Investment in technical guiding to obtain information about: what to plant, in what quantities, at what time of the year; how often...
- **Reprocess PDA** - Prevent FLW from following pre-defined destinations, so that the supplier has greater economic gain. For this measure FLW must be consumable, as is the case with most foods that do not meet the retailers' specifications. The Fig.2 represents the material flows (goods, FLW, and inputs) as well as their possible destinations. As shown in the figure, suppliers start receiving F&V (inputs). Part of this food is transported to JM because it meets their specifications (goods supplied). The rest, which do not comply with

specifications, are FLW and can go to pre-defined destinations or to alternative destinations where there is greater valuing of FLW. These last destinations consist on reprocessing FLW at suppliers (Processed F&V; Juices and Soups) or involve other *stakeholders* (Central Kitchens, Secondary Market).

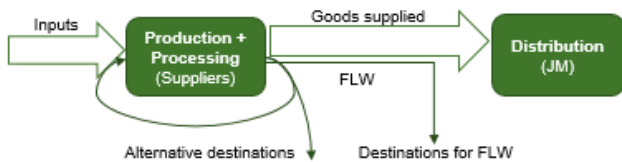


Fig.2 – Operation for alternative destinations at suppliers

As for measures taking place downstream JM's supply chain, the following measures are being implemented in PD Stores:

- **Educate employees** – Having Jerónimo Martins Training School to educate employees on each product and how to handle it.
- **Investment in infrastructure** - Use circular displays for easier access to the product and less risk of damaging it.
- **Develop products** - Create “Atelier de Fruta” in stores to improve defective F&V, by eliminating damaged parts and encourage purchase. Also, implement tastings to prove that products with bad appearance can taste better.
- **Review promotion policies** – Use depreciation tags to encourage purchase of products close to its expiration date.

These measures require effective stock control, in order to identify which products should be selected for each measure.

3. Literature Review

3.1. Sustainability and Circular Economy

Sustainability is defined as the ability to satisfy the needs of the present, without compromising future generations. According to the Triple Bottom Line Approach (TBL) it takes into account the impact on 3 dimensions: environment, economic and social (Elkington, 1998).

It happens that the current model of linear economy in which products are manufactured from raw materials, sold, used and finally disposed, jeopardizes sustainability (EMF, 2013). Structural change is necessary, and CE is an alternative. Unlike the linear economy, CE has the principle of maintaining a balance between the 3 dimensions of TBL (Sauvé, Bernard, & Sloan, 2015). The model uses end-of-life materials as resources, combating scarcity of resources and climate change, with less GHG emissions. The model

closes life cycles and consequently decreases the volume of waste. In order to introduce CE, it is necessary to implement 6 strategies (6R): Reduce; Reuse; Recycle; Repair; Remanufacturing; Redesign (Bradley, Jawahir, Badurdeen, & Rouch, 2018).

3.2. Sustainable Supply Chain Management

Sustainable Supply Chain Management (SSCM) is described as “the creation of coordinated supply chains through the voluntary integration of economic, environmental, and social considerations with key inter-organizational business systems designed to efficiently and effectively manage the material, information, and capital flows associated with the procurement, production, and distribution of products or services in order to meet stakeholder requirements and improve the profitability, competitiveness, and resilience of the organization over the short and long-term”(Ahi & Searcy, 2013). Thus, one of the steps to develop a correct SSCM is to assess the level of sustainability of the supply chain. This process has 2 big challenges. One is the constant interaction between stakeholders which makes it difficult to evaluate each one of them separately. The other is the multiple dimensions of sustainability that sometimes can have different goals (Tajbakhsh & Hassini, 2015).

3.3. Food Loss and Waste

According to FAO, food loss and food waste are both the decrease of quantity or quality of food. However, while food losses occur from harvest to retail, food waste occurs in the retail and the consumer stages (FAO, 2019). To aggregate these two concepts, FLW is defined as the decrease of quantity or quality of food throughout the entire supply chain regardless of the associated cause (HLPE, 2014). As for what is considered to be FLW, there are different approaches. Some include inedible parts of food in FLW (FUSIONS, 2016) while others don't (FAO, 2019).The determining factor for FLW, especially when it comes to perishable products, is the time interval between harvest and food consumption. The quality of the food tends to decrease the greater this interval (HLPE, 2014).

Regarding how to measure FLW, there are different metrics available such as Mass, Calories and Economic Value to measure quantity and Nutritional Value, Economic Value and Food Safety to measure quality (FAO, 2019; HLPE, 2014). The methodology Food Loss and Waste Protocol (Hanson et al., 2016) used by JM to

measure FLW and report it has the 10 following steps: (1) Define goals, (2) Review accounting and reporting principles, (3) Establish scope, (4) Decide how to quantify FLW, (5) Gather and analyze data, (6) Calculate inventory results, (7) Assess uncertainty, (8) Perform review, (9) Report FLW inventory, (10) Set target and track over time. The (3) step requires the company to define its scope of FLW inventory, meaning:

- **Time frame** – the period of time for which the inventory is being reported.
- **Material Type** – materials that are included in the inventory (food only, inedible parts only, both).
- **Destination** – where FLW goes when removed from the food supply chain.
- **Boundary** – the food category, life cycle stage, geography, and organization.

Regarding FLW worldwide, according to FAO, 30% of the food produced annually for human consumption results in FLW, the equivalent to 1.3 billion tonnes (FAO, 2011). In developing countries FLW typically occurs upstream the supply chain, while in developed countries FLW occurs downstream (Champions 12.3, 2019). As for the type of food, F&V present the highest FLW worldwide (Lipinski et al., 2013) and in Portugal (Baptista, Campos, Pires, & Vaz, 2012), thus justifying the focus of this study.

As for the negative impacts of FLW, they can be categorized into the 3 dimensions of TBL:

- **Economic** – FLW implies costs. They are equivalent to the decrease of commercial value of the food, the cost of production and the cost of managing waste. Worldwide, the cost of FLW is 936 billion dollars per year, the equivalent to the GDP of some countries such as Indonesia or the Netherlands (FAO, 2015).
- **Environment** – FLW implies unnecessary use of natural resources and GHG emissions, deforestation and the decrease in biodiversity (Hanson et al., 2016).
- **Social** – FLW contribute to hunger in the poorest communities. Given that all countries buy on the global market, products that result in FLW are being withdrawn from this same market and contributing to price increases, making them less accessible to the poorest countries (FAO, 2013).

3.4. Agro food Supply Chains

A food supply chain is defined as a “set of interdependent companies that work closely together to manage the flow of goods and services along the value-added chain, in order to realize superior customer value at the lowest possible costs” (Folkerts & Koehorst, 1998). An agro food

supply chain has the particularity of managing agricultural and horticultural products (Ahumada & Villalobos, 2009). This type of products present high perishability, that is, their quality decreases rapidly over time reaching a null value after the expiration date.

The primary stakeholders in this type of chain are: **Farmers** who produce food; the **Food Industries** that process them and add value to them; the **Retailers** who distribute them; the **Consumers** who buy them. In addition to these, there are secondary stakeholders who have an impact in the chain with their services. This category includes: subcontracted logistics providers (3PL) who can ensure transport, warehouse, waste management, among others; non-governmental organizations (NGOs) that regulate the industry; financial institutions that allow loans and investments; public administration whose policies directly affect the business (Dania, Xing, & Amer, 2018).

Regarding the different stages of this supply chain, in **Production** there is a tendency for farmers to cooperate with each other to benefit from economies of scale and have access to certain technologies (Brah & Schelleman, 2000). In **Processing** there has been an increase in the consumption of processed products in developed countries, which justifies a greater investment in this stage. **Distribution** is the stage with the greatest influence on the supply chain since it dictates the specifications of the products (HLPE, 2014). The **Consumption** stage has been gaining relevance as consumer preferences can have an impact on retailers' specifications (Brah & Schelleman, 2000).

Regarding FLW across this supply chain, the results vary according to geographic area. In Portugal, the most efficient stage is processing. The stages of production and consumption present higher FLW (Baptista et al., 2012).

To solve FLW, the identification of its causes throughout the supply chain is essential to prioritize efforts and develop targeted solutions. An integrated perspective of the supply chain is mandatory, as FLW happening at a given stage can be caused by actions from other stages (HLPE, 2014). The following causes are the most relevant for F&V in each stage:

- **Production** – Natural causes; poor crop choice, harvest at the wrong time, crops left in the field, difficult alignment of supply and demand, difficult stock management; long duration of operation; inappropriate handling; poor temperature and humidity control; strict distribution specifications; limited processing capacity.

- **Processing** – Technical problems; inefficient packaging; strict delivery time policies.
- **Distribution** – Food stacking; excessive handling of consumers; high quantity and variety of food on display; strict policies regarding expiry dates.
- **Consumption** – lack of knowledge about expiry dates; lack of planning in the purchasing process; poor storage management; big portions in packages and cooking; weak cooking techniques. As for the measures to minimize and value FLW, there are some general for all stages of the supply chain and others more specific for each stage:
 - **General** – Report FLW results; promote donations; develop FLW destinations; educate employees; improve inventory management; investment in infrastructures and technology.
 - **Production** – Cooperation between suppliers; Adjust volume of production; enhance techniques.
 - **Processing** – Restructure processing; reprocess FLW; develop products and packaging.
 - **Distribution** – Sell products that do not meet rigid specifications; consumer surveys; value local production; change expiration dates information; review promotion policies.
 - **Consumption** – educational campaigns.

4. The method of Benchmarking

4.1. Concept

Benchmarking is defined as the process that aims to improve any performance in any organization by identifying and applying best demonstrated practices, which can be found everywhere and lead to competitive advantage (Camp, 1989). This method requires the company to share information, good communication within the company and investment of resources (Anand & Kodali, 2008).

4.2. Types of Benchmarking

There are different types of Benchmarking. The method can be classified regarding its **Nature; Content and Purpose**. Nature evaluates with whom the comparison is made, that is, who are the Benchmarking Partners. These can be **Internal** (other units of the company itself) or **external: Competitive** (direct competitors); **Functional** (industry); **Generic** (other industries). Content evaluates what is being compared: **Performance** (KPIs); **Process** (processes); **Strategic** (strategies)(Anand & Kodali, 2008; Erdil & Erbiyik, 2019).

As for Purpose, it can be: **Competitive** or **Collaborative**. The first occurs when the company wants to gain a superior position in relation to its competitors. The second occurs when the company wants to create an educational

environment to share knowledge dados (Wah Fong et al., 1998). Benchmarking results from the combination of these dimensions, however, not all have the same relevance.

4.3. Model

After a literature review, it's concluded there's not only one model for the method of Benchmarking. However, the authors agree the most transversal model regarding the types of Benchmarking and also the most cited is the model by Camp (Anand & Kodali, 2008; Camp, 1989). It follows the Deming cycle, also known as the PDCA cycle (Plan, Do, Check, Act)(Wah Fong et al., 1998). The Camp model has 4 different phases: **Planning; Analyze; Integrate; Act**; with the following 10 steps: (1) Identify benchmarking subject; (2) Identify benchmarking partners; (3) Determine data collection method; (4) Determine current competitive gap; (5) Project future performance; (6) Communicate findings and gain acceptance; (7) Establish functional goals; (8) Develop action plans; (9) Implement plans and monitor progress; (10) Recalibrate the benchmark.

4.4. Benchmarking Sustainable Supply Chains

The literature review regarding Benchmarking Sustainable Supply Chains is quite scarce given its specificity. Even though there is not a model recognized worldwide, there are interesting frameworks that can be integrated into the generic model of Camp, more precisely, in the Analyze phase of the model. Colicchia, Melacini, & Perotti (2011) e Rao & Holt (2005) propose a framework with 2 phases. The first phase identifies possible sustainable measures for each stage of the supply chain. The second evaluates the level of adoption of these measures by the company for each stage of the supply chain.

To assess how each company (k) adopts sustainable measures for each stage of the supply chain (j), the Environmental Performance Index (EPI) is calculated:

$$EPI_{k,j} = \frac{\sum_{i=1}^{N_j} S_{k,i,j} * W_{i,j}}{N_j} * 100$$

Where the variables have the following representation:

$S_{k,i,j}$ - Binary variable, equal to 1 if measure i is adopted in step j by company k, and equal to 0 in the opposite case;

$W_{i,j}$ - Impact of initiative i adopted in step j on total sustainability;
 N_j - Total number of possible sustainable measures in step j .

The company's global performance (EPI_k) is then an average of $EPI_{k,j}$ for each of its stages. EPI_k represents the company's effort to incorporate sustainability into its operations.

The possible sustainable measures from the first phase can have different impacts on the company's sustainability, meaning, there are measures more sustainable than others. To take this factor into account, when calculating $EPI_{k,j}$ different weights are assigned to each of the measures ($W_{i,j}$).

To present the EPI results two approaches are proposed, namely: radar chart and box plots. Radar charts are useful to present the results from each company. It is also used in Benchmarking as it facilitates the comparison between companies, specifically their level of adoption of sustainable measures per stage of the supply chain. Boxplots are used for aggregated analysis, especially when dealing with a high number of companies. It allows an analysis per stage of the supply chain, concluding which has the best results in adopting sustainable measures.

5. Applying Benchmarking to Case Study

Given the literature review about the method of Benchmarking, the goal is to apply to the case study the integration of the Camp Model (1989) with the framework of Colicchia, Melacini, & Perotti (2011) e Rao & Holt (2005) in the Analyze phase. Though, in this study only the first two phases of the Camp model are developed (Fig.3).

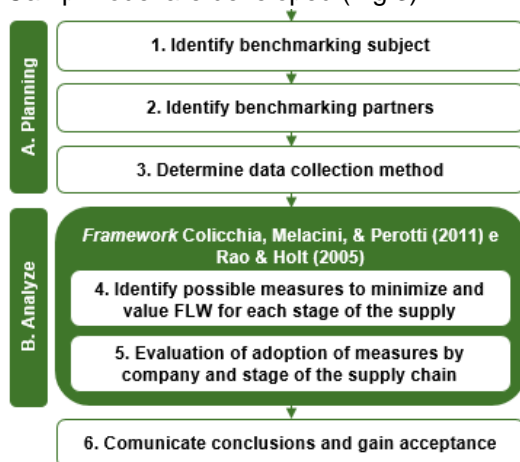


Fig.3 – Methodology for case study

5.1. Planning

This phase of the methodology contains 3 steps. Regarding (1) identifying benchmarking subject,

this step defines the type of Benchmarking to use in the case study, that is, the 3 dimensions: Nature, Content and Purpose. For Nature, a **Functional** Benchmarking was chosen to compare JM with other companies in food retail. For Content, a **Process** benchmarking was chosen to compare processes and practices to minimize and value FLW of F&V. For Purpose, a **Competitive** Benchmarking was chosen given this study started as an individual initiative of JM to gain a superior position in relation to its competitors. The combination of Functional and Process Benchmarking chosen for this case study theoretically has a high added value.

Regarding (2) identifying benchmarking partners, this step defines with which companies in the food retail should JM compare its processes and practices for minimizing and valuing FLW of F&V. On one hand, national companies were selected as they are direct competitors of PD. On the other, international companies were selected, because they have the best demonstrated practices. To choose the companies 2 key success factors were taken into consideration: **volume of revenue** and **level of sustainability**. The companies should be successful in both KSFs. To evaluate its performance, Deloitte's annual report "Global Power of Retailing" (Deloitte, 2020) was used to assess volume of revenue and the DJSI annual report (DJSI, 2020) to assess the level of sustainability. Thus, the following international competitors were obtained: Tesco; Kroger; Walmart. As for the national competitors, given they are not evaluated in the DJSI report, only the Deloitte report was taken into account. Thus, the following companies were selected: Continente; Auchan; Lidl.

Regarding (3) determining data collection method, this step defines how and where to collect information about JM and Benchmarking Partners. In this study, there was no direct access to Benchmarking Partners. For this reason, only secondary sources were used to obtain information about the processes and practices used by them to minimize and enhance FLW of F&V. In contrast, almost all information regarding the operation of JM was obtained from primary sources, that is, guided tours and meetings with directors from various departments.

5.2. Analyze

In this phase of the methodology, the framework of Colicchia, Melacini, & Perotti (2011) e Rao & Holt (2005) is integrated. Regarding its first step, the identification of possible measures of minimization

and valuing FLW of F&V per stage of the supply chain, it has already been developed in Section 3.4. Regarding its second step, the evaluation of the adoption of these measures for each stage of the supply chain, information about JM has already been presented in Section 2.4. As for measures implemented by the Benchmarking Partners, they are identified in Tab.1 with 1.

With the implemented measures identified, follows the calculation of the index $EPI_{k,j}$ which assesses how each company (k) adopts measures by each stage of the supply chain (j). According to its formula from Section 4.4, it is necessary to assign weights $W_{i,j}$ to each of the measures.

In this case study, to assign weights it was taken into account a study from consultant BCG (BCG, 2018). According to this study, it is possible to categorize measures of minimization and valuing FLW of F&V into 5 groups: Awareness; Supply Chain Infrastructure; Supply Chain Efficiency; Collaboration and Environmental Policies. The study concludes that a global effort to implement all measures from these 5 groups can reduce FLW annually by 700 billion dollars, with each category having a different reduction impact. To calculate weights for the measures, it was considered that measures in the same category have identical weights. Thus, in order to obtain weights for each category, the impact of each category (ex: 260 billion dollars) was divided by the total impact of the

5 categories (700 billion dollars). The following weights were established: Awareness(0.37); Supply Chain Infrastructure(0.21); Supply Chain Efficiency(0.17); Collaboration(0.09); Environmental Policies (0.16).

With the variables $S_{k,i,j}, W_{i,j}, N_j$ defined it was possible to calculate the index $EPI_{k,j}$. Tab.1 presents the defined variables and the index $EPI_{k,j}$ results.

When analyzing these results, PD stands out with the maximum value in General measures, having all these measures implemented. Also, PD presents good results in the Production and Processing stages mainly due to JM's closeness to its suppliers, which translates into a strong development of sustainable products and reprocessing FLW (Central Kitchens and Processed F&V).

On the other hand, PD has scope to improve its performance in downstream stages. Despite the positive results in the Distribution stage, PD continues to show worse results than its direct competitor Continente. The fact that these banners are equivalent in size and operate in the same context suggests that there are measures that can be replicated at this stage. Regarding the Consumption stage, it is difficult to explore the results since there is only one possible measure to be implemented specifically in this stage: "Educational campaigns". For this reason the

Tab.1 – Calculation of $EPI_{k,j}$

		INTERNACIONAL			NACIONAL				
		Pesos	Tesco	Kroger	Walmart	PD	Continente	Auchan	Lidl
GENERAL	Report FLW results	0,17	1	0	0	1	0	0	0
	Promote donations	0,16	1	1	1	1	1	1	1
	Develop FLW destinations	0,21	1	1	1	1	0	0	0
	Educate employees	0,37	0	1	0	1	0	0	0
	Improve inventory management	0,17	0	0	0	1	0	0	0
	Investment in infrastructures and technology	0,21	1	0	1	1	1	1	1
	EPI	1,29	58%	57%	45%	100%	29%	29%	29%
PRODUCCION	Cooperation between suppliers	0,09	1	0	0	0	1	0	0
	Adjust volume of production	0,09	1	0	0	0	0	0	0
	Enhance techniques	0,37	0	0	0	1	1	0	0
	EPI	0,55	33%	0%	0%	67%	84%	0%	0%
PROCESOS	Restructure processing	0,21	0	0	0	0	0	0	0
	Reprocess FLW	0,21	1	0	1	1	1	0	0
	Develop products and packaging	0,37	1	1	0	1	1	0	1
	EPI	0,79	73%	47%	27%	73%	73%	0%	47%
DISTRIBUCION	Sell products that do not meet rigid specifications	0,16	1	1	1	0	1	1	0
	Consumer surveys	0,09	0	1	0	0	0	0	0
	Value local production	0,17	0	0	1	1	1	1	1
	Change expiration dates information	0,16	1	1	0	0	0	0	0
	Review promotion policies	0,37	1	0	1	1	1	1	1
	EPI	0,95	73%	43%	74%	57%	74%	74%	57%
CONSUMO	Educational campaigns	0,37	1	1	0	0	1	0	1
	EPI	0,37	100%	100%	0%	0%	100%	0%	100%

1 ou 0 – Binary variable implementation $S_{k,i,j}$ (1-Yes/0-No)
X – Variable weight $W_{i,j}$
X – Variable sum weights N_j
X% - Result $EPI_{k,j}$

results are binary, either 0% or 100%. Unlike some national competitors, including Continente, PD does not apply this measure.

Also worth noting, there are situations in which competitors implement the same number of measures and the results of the index are different. For example, in Production stage, Tesco and PD both adopt 2 different measures. Tesco opts for “Adjust production volume” which has less impact on minimizing and valuing FLW than “Enhancing techniques” which is implemented by PD. This difference in impact is represented by weights and contributes to a lower index for Tesco. This shows that even though it is important to implement the largest number of measures, it’s essential to know which ones have the greatest impact on minimizing and valuing FLW.

In addition to analyzing the results by company, it is also possible to make an aggregate analysis on the food retail industry. According to the results, there’s less adoption of general measures than specific measures for the different stages of the supply chain. When comparing the results of the upstream stages, there is a greater number of companies adopting measures in Processing versus Production stage. This is due to the better communication between retailers and food industries versus retailers and producers. Typically, food industries correspond to the largest % of retailers’ suppliers.

Analyzing the measures individually, it appears that international competitors all seek to “Promote donations”; “Develop FLW destinations” and “Sell products that do not meet strict specifications”. National competitors, on the other hand, all seek to “Promote donations”, “Invest in infrastructure and technology”, “Enhance national production” and “Review promotion policies”.

Finally, it is possible to obtain the global EPI_k for each company from the average of its $EPI_{k,j}$. This index represents the effort of each company to minimize and value FLW throughout its supply

chain. The results of the international and national competitors are the following: Tesco (67%); Kroger (49%); Walmart (29%); Continente (72%); Auchan (29%); Lidl (46%). PD obtains a global index of 60% which places it in 2nd among international competitors (after Tesco) and national competitors (after Continente).

5.3. Recommendations

After the previous analysis, it is concluded that PD has scope to improve its performance in minimizing and valuing FLW of F&V. In this context, the goal is to propose a set of measures to PD. To select these measures several factors must be taken into account, such as: the size of the company; the company's resources; impact of each measure; cost the measure and duration of its implementation. The first two factors filter measures appropriate to the sales volume, type of business and know-how of JM. The third factor takes into account the weight of the measure and its impact on the results of EPI. The last two factors are related to the company's availability to spend resources (money and time) in the implementation of measures. These latter factors are limitations of the case study as Section 6.1 explains.

Taking into account the previous factors, 3 scenarios were recommended (Fig.4). Scenario A is the least aggressive, that is, the one that requires the least expenditure of resources (money and time), but consequently has the least impact on FLW of F&V. Scenarios B and C require progressively greater expenditure of resources and consequently have a greater impact on FLW of F&V. Into more detail, scenario A focuses mainly on the stages downstream of the supply chain given these present the worst results of EPI in PD. “Sell products that do not meet strict specifications” is quite common in international and national competitors and should therefore be a priority to PD. Creating a different range for F&V that do not meet specifications is the common practice,

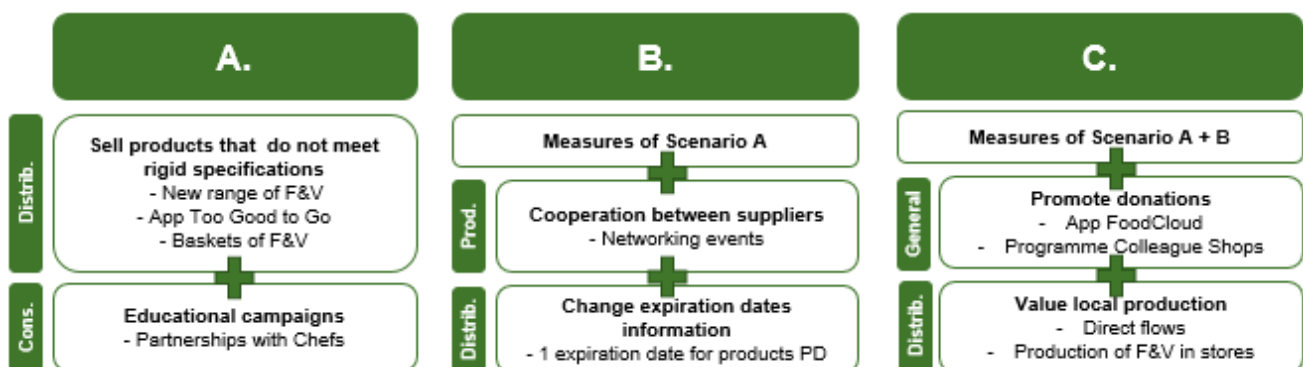


Fig.4 – Scenarios recommended to JM

however, more innovative ways to minimize FLW in stores are suggested such as the App Too Good To Go that sells food surpluses daily or having baskets with F&V close to its optimal consumption point at reduced prices. As for the “Educational Campaigns”, it’s suggested partnerships with chefs that can educate consumers about how to cook and store F&V.

Scenario B contains scenario A’s measures and two others. “Change expiration dates information” is quite common at the international level, but innovative at the national level. If JM is interested in standing out from its direct competitor Continente, this would be a good opportunity to become leader. The suggestion would be to initially implement one expiration date on its own products to assess the impact of the measure. As for “Cooperation between suppliers”, despite PD already showing good results in the Production stage, there is an opportunity for JM to promote relationships between suppliers given its extensive portfolio of contacts. It is therefore recommended to create networking events.

Scenarios A and B propose priority measures that have not yet been implemented in PD. Scenario C, in addition to these measures, proposes improvements to measures already implemented. Regarding “Promote donations”, it’s the only common measure to international and national competitors, though with little innovation nationally. Thus, it’s recommended to improve this measure either by developing an App such as FoodCloud that provides information at the end of the day to charities about food surpluses per store, or by implementing programs such as Colleague Shops that makes food close to the expiration date available to employees. As for “Valuing local production”, on the one hand, it is recommended the study of possible direct flows from producers to stores to highly perishable products. On the other hand, it’s advised to study the possible production of F&V in certain PD stores.

6. Conclusions

This study was motivated by the need to improve JM’s FLW to ensure greater sustainability. To solve this issue, the company JM and its supply chain of F&V were analyzed. This allowed to better understand the problem of FLW. Then, a literature review was carried out in order to understand the urgency to solve the problem and obtain theoretical bases on how to do so. This led to the development of a Benchmarking methodology that evaluated the current measures of minimization and valuing FLW of F&V of PD’s supply chain and

of successful companies from the food retail industry. The application of the method allowed to conclude that PD has scope to improve its performance, as the banner obtains a global index of 60% which places it in 2nd among international competitors (after Tesco) and national competitors (after Continente). To improve the position of PD, and taking into account the measures implemented by Benchmarking Partners, 3 scenarios with a different set of measures were recommended to JM (Fig.4).

Apart from the recommendations, the present study is also an opportunity to learn more about: food retail industry (especially about JM); complexity of the agro food supply chain given its high number of stakeholders and the importance of each one; FLW worldwide and by stage of the supply chain; negative impacts of FLW; causes for FLW and measures to use to mitigate them; how the food retail industry deals with FLW of F&V; how the Benchmarking methodology can be useful in improving processes.

6.1. Limitations

Since the main goal of the paper is applying the Benchmarking methodology to the case study, the limitations are very much related to the method:

- Assigning weights to minimizing and valuing FLW measures $W_{i,j}$
- Different ways of implementing measures
- Same measures for different F&V
- Different sources of information
- Lack of cost and duration information

6.2. Suggestions for future studies

The priority for future studies is to finish the Benchmarking methodology, since this paper only develops the first 2 phases of the Camp model. Taking into account the recommendations proposed to JM, it should be developed an action plan and its implementation and monetarization. It is also advised an in-depth study of the costs and duration of each measure so a Gantt Diagram can be developed. As Benchmarking is a continuous method, JM should constantly evaluate Benchmarking Partners’ measures and conclude if there are opportunities to improve PD’s performance with FLW.

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