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Waste Management

Causes and prevention practices of food waste in fruit and vegetable supply chains: How is Brazil dealing with these issues?

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Abstract:	<p>This study aims to identify the main causes of food waste (especially fruit and vegetables) and their relationship with prevention practices at supermarket and supplier levels. To do so, we conducted case studies in four Brazilian supermarket chains and their suppliers. Our findings show that although supermarkets seem to be concerned about avoiding food waste, they mostly focus on internal prevention actions, reflecting the lack of collaboration and information between supermarkets and suppliers. The low investment of supermarkets in actions to prevent food waste is focused only on their internal operations and, despite this, training is inefficient due to the high level of staff turnover and lack of involvement of suppliers in participating in this training. The use of technologies such as packaging, traceability, refrigeration, and transport equipment is insufficient, it increases production costs. A lack of strict legislation in Brazil makes it difficult for supermarkets and suppliers to donate food. Cultural issues specific to Brazil, such as consumer overhandling fruit and vegetables before buying these products, generate a great deal of waste. The paper contributes to the literature by identifying the main root causes of food waste and providing a list of prevention practices that supermarkets and suppliers can benefit from. Managerially, it can help supermarket managers spot the causes of food waste within their operations, and hence change, improve or implement practices and behavior to prevent food waste.</p>

Highlights

- Identify the relationship between causes and practices of waste prevention in supermarkets and suppliers
- Consumers demand high aesthetic standards from fruit and vegetables
- Inventory reallocation and minimum amount displayed of F&V reduce waste
- Supermarkets in this study prefer to discard food as there are no legal penalties
- Self-interest of retailers is reinforced through a limited and reactive coordination

1 Causes and prevention practices of food waste in fruit and vegetable supply chains: How
2 is Brazil dealing with these issues?

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23 Abstract

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26 conducted case studies in four Brazilian supermarket chains and their suppliers. Our findings
27 show that although supermarkets seem to be concerned about avoiding food waste, they mostly
28 focus on internal prevention actions, reflecting the lack of collaboration and information
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30 food waste is focused only on their internal operations and, despite this, training is inefficient
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56 1. Introduction

57 Food waste (FW) refers to any food originally produced for human consumption; however, it
58 is deliberately discarded while still suitable for consumption (IFPRI, 2016). It represents a
59 major misuse of natural resources such as water, land, and energy, while generating needless
60 greenhouse gas emissions, which can also overload disposal and treatment processes (Parfitt et
61 al., 2010, Gustavsson et al., 2011). Concomitantly, FW is a paradox, considering that about
62 one-third of world food production is wasted globally, and at the same time, between 702 and
63 828 million people were affected by hunger in 2021 (Gustavsson et al., 2011, FAO, 2022).

64 Preventing FW requires coordinated efforts from multiple stakeholders in a food supply
65 chain (FSC), so as to decrease social, economic, and environmental costs and demands greater
66 efficiency in food supply chains (FSCs) in order to increase food security, improve waste
67 prevention rates, and consequently contribute to a more sustainable environment (Lu et al.,
68 2022). Its challenges have been discussed in the economic, governmental, and academic fields
69 in recent years (Diaz-Ruiz et al., 2019, Özbük; Coskun, 2020). The Sustainable Development
70 Goals emphasize the urgency of sustainable production and consumption in Goal 12.3, which
71 is to halve food waste at the retail and consumer levels and reduce food losses along production
72 and supply chains, including post-harvest losses by 2030 (UN, 2015).

73 In the retail area, some studies have highlighted the causes of FW (Mena et al., 2011, Holweg
74 et al., 2016, Canali et al., 2017, Teller et al., 2018) and prevention practices (Thyberg; Tonjes,
75 2016, Diaz-Ruiz et al., 2019, Cicatiello; Franco, 2020). Regarding location, the research is
76 focused on the reality of developed countries (mainly in Europe), such as Italy (Muriana, 2017,
77 Cicatiello; Fraco, 2020), France (Albizzati et al. 2019), the UK (Mena et al., 2011, Mena et al.,
78 2014, Rodrigues et al., 2021), Spain (Derqui et al., 2016, Diaz-Ruiz et al. 2019), Finland
79 (Lehtokunnas; Pyyhtinen, 2022), Sweden (Brancoli et al., 2017), and Germany (Priefer et al.,
80 2016, Horós; Ruppenthal, 2021, Riesenegger; Hübner, 2022). Furthermore, the articles cited

81 above do not explore the relationship between the causes of FW and prevention practice, and
82 only a few focus on the supplier and supermarket level, such as Mena et al. (2011) and Teller
83 et al. (2018). On the other hand, although Moraes et al. (2020) delve into a cause-practice
84 relationship, their results are limited in the sense of not being empirically validated.

85 Few of these studies discuss FW generated by supermarkets and suppliers (Mena et al., 2011,
86 Teller et al., 2018, Horós; Ruppenthal, 2021). In emerging countries (such as Brazil), studies
87 focus on post-harvest losses in supply centers (Santos et al., 2020), green and marketing
88 strategies to mitigate waste in supermarkets (Gustavo Jr. et al., 2021, Souza et al., 2021), waste
89 quantification in restaurants (Matzembacher et al., 2020) and its causes (Watanabe et al., 2022),
90 reducing perishable processed food disposal in industry-retail symbiosis (Trento et al., 2021)
91 and causes of waste in the Brazilian beef supply chain (Magalhães et al., 2020). Nevertheless,
92 these studies do not address which causes of FW are the most common and what prevention
93 practices are related to them in suppliers and supermarkets. Most of the discussions in the
94 literature do not reflect the realities and diversity of retailers in emerging countries (FAO, 2019,
95 Soma, 2019) and, consequently, do not consider issues related to their interfaces with suppliers,
96 which could make it difficult to take appropriate actions (Moraes et al., 2020).

97 Among different retail formats, supermarkets around the world have a significant impact on
98 influencing FSCs (Cicatiello et al., 2016; Brancoli et al., 2017). They have extensive access to
99 research and technologies, which can lead to major changes by providing leadership in
100 innovation, education, and information sharing to mitigate FW throughout FSCs (Teller et al.,
101 2018). This is especially true because they have daily and direct contact with consumers. In
102 Brazil, for instance, around 28 million consumers (i.e., 13% of the population) go to
103 supermarkets on a daily basis (ABRAS, 2021).

104 The Brazilian retailer sector is predominantly formed by groups of large companies, which
105 are multinationals or regional chains, and to a lesser extent by small companies (Concha-Amin

106 and Aguiar, 2006). In 2021, the whole retail sector reached a revenue of R\$ 611.2 billion,
107 through the operation of all its formats and distribution channels (neighborhood market,
108 supermarket, hypermarket, cash and carry, and e-commerce) (ABRAS, 2022). This represents
109 7.03% of the national Gross Domestic Product (GDP). Furthermore, this sector has a direct
110 relationship with suppliers, mainly distributors and, to a lesser extent, farmers (ABRAS, 2022).

111 There are several challenges that emerging countries (in particular) face in dealing with FW.
112 Brazil, for instance, faces a serious economic and social crisis caused by COVID-19, in which
113 approximately 33 million people are suffering from hunger (Rede Penssan, 2022) and a rise in
114 the population under food insecurity. Furthermore, successful government food security
115 programs are suffering budget constraints (Henz and Porpino, 2017), which make the income
116 inequality worse. Above all, there is a lack of empirical studies on this topic that aggravates the
117 limited funding for FW mitigation actions in the public and private sectors.

118 Even before the pandemic, approximately 26 million tonnes of food were wasted annually, in
119 which 5.3 million tonnes are related to fruit and 5.6 million tonnes to vegetables (ABRAS,
120 2019). From the total amount of daily food wasted in Brazil, 40% occurs in distribution, in
121 which retail accounts for 12% (Gustavsson et al., 2011). The rate of fruit and vegetable (F&V)
122 waste in supermarkets in 2020 represented 5.25% of its gross revenue, and was one of the
123 highest percentages compared to other perishable categories, such as bakery (2.74%) and
124 butcher products (2.62%) (ABRAS, 2021). Moreover, the F&V sector in Brazilian
125 supermarkets is responsible for increasing the daily traffic of customers within stores
126 (Lourenzani; Silva, 2004) in the search for fresh produces.

127 Considering the supermarket's downstream position in FSCs, food has already gone through
128 most of its value-added stages, accumulating costs for suppliers and consumers (Mena et al.,
129 2011), and is a waste of natural resources such as land, energy and water (Göbel et al., 2015).

130 Large quantities of F&V are wasted in supermarkets, as well as among their suppliers due
131 to several causes. Some of them are: high quality standards that emphasize the aesthetic
132 appearance of products (Garrone et al., 2014, Teller et al., 2018); short shelf life (Kaipia et al.,
133 2013, Tromp et al., 2016); problems with transportation and packaging (Mena et al., 2014,
134 Tromp et al., 2016); and inadequate demand forecasting (Mena et al., 2011, Holweg et al., 2016,
135 Teller et al., 2018; Magalhães et al., 2020).

136 Therefore, FW is a problem that may trigger financial and reputational losses for
137 supermarkets and their suppliers (Refed, 2018). At the same time, increasing public attention
138 to the social dimension of FW puts pressure on companies to show their efforts and actions
139 from a corporate social responsibility perspective (Teller et al., 2018; Cicatiello; Franco, 2020).
140 To help fill many of the gaps, studies on F&V need to be addressed to guide supermarkets in
141 their practices to combat FW, considering their great power and influence in the FSC.
142 Furthermore, understanding the key causes of FW and having a list of FW prevention practices
143 may assist supermarket managers in making decisions about sustainable and social corporate
144 responsibilities, and even increasing their role and importance in reducing FW by influencing
145 consumers to play their roles best.

146 Thus, this study aims to contribute to the debate about FW by identifying the main causes of
147 FW and their relationship with prevention practices at supermarket and supplier levels.
148 Moreover, by doing this from the perspective of an emerging country, it contributes to the
149 analysis of the relationship between the activities that generate waste (causes) and the
150 prevention practices used in the dyad, between the supermarket and suppliers.

151 The article is structured as follows. Section 2 presents the materials and methods used in this
152 research. The results are presented in Section 3, while a discussion about FW causes and
153 prevention practices can be found in Section 4. Finally, the conclusions are drawn in Section 5.

155 2. Materials and method

156 Figure 1 presents the main steps followed in this research.

157 -----

158 Insert Figure 1 about here

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161 *Step 1: Conceptual framework*

162 First, the causes and prevention practices of FW were adapted from Moraes et al. (2020),
163 which was the most recent study that produced a set of 34 causes of FW and 32 reduction
164 practices of FW in the retail sector, focusing on the relationship between the supplier and the
165 retailer through a systematic literature review. Thus, it provides a comprehensive framework to
166 understand the causes and prevention practices of FW. However, to simplify the data analysis
167 in our study, causes and prevention practices of FW that hold similar characteristics were
168 revised and grouped. For example, FW causes such as “problems with transport equipment,”
169 “problems with display,” and “problems with storage” were merged into “transport equipment
170 and storage structure problems.” Therefore, it resulted in 26 causes and 18 prevention practices
171 (see Table 1), which were the basis for Step 2 (Field Research).

172 -----

173 Insert Table 1 about here

174 -----

175 *Step 2: Field Research*

176 A case study method was chosen as the most suitable approach because it focuses on the
177 understanding of the dynamic environment within some desired settings, and is able to explore,
178 explain and describe the phenomenon of interest (Eisenhardt, 1989; Voss, 2008; Barratt et al.,

179 2011). We chose to study Brazilian supermarket chains ranked among the 50 largest by the
180 Brazilian Association of Supermarkets (ABRAS, 2017). Among those, we selected the ones
181 with investments in prevention practices of FW, according to experts and secondary data
182 sources (e.g., websites, organization newsletters, and internal documents).

183 The unit of analysis in this study is the distribution, storage, and display in the supplier–
184 supermarket dyads. A research protocol was used to ensure the rigor and reliability of the data
185 collection for the case study (Eisenhardt, 1989; Yin, 2010), as well as the script validation by
186 experts. First, a pilot test was carried out with one supplier and one retailer (Voss, 2009; Yin,
187 2010). Afterward, 12 exploratory interviews were conducted with experts (such as consultants
188 in waste prevention, retail associations, researchers and academics, and non-government
189 organizations - NGOs) (Appendix A). Data from these interviews were used to better
190 understand the sector, the unit of analysis, and to increase the validity of the findings.

191 In total, four supermarkets and two suppliers (producers and wholesalers) from each chain
192 (Table 2) agreed to participate in this research. The suppliers were selected based on the types
193 of products they marketed (Mena et al., 2014): (1) products with a short shelf life, such as
194 strawberries, bananas, tomatoes, and lettuce; and (2) products with a medium or long shelf life,
195 such as apples, citrus fruit, onions, potatoes, and broccoli.

196 -----

197 Insert Table 2 about here

198 -----

199

200 Then, 35 interviews (Appendix B) were conducted with retailer and supplier employees in
201 the studied cases: A (7 individuals), B (12 individuals), C (9 individuals), and D (7 individuals).
202 Data were collected between February and November 2018; at least, one of the authors led the
203 interviews and they were recorded when authorized. The semi-structured interview addressed

204 three blocks of questions: 1) company and chain structure (e.g., inflows and outflows of food,
205 supplier certification, employees working directly with fruit); 2) aspects of waste (e.g., activities
206 that generate waste, what the amount is, waste measurement and monitoring process, indicators
207 and those responsible for it); 3) prevention practices (such as practices to avoid waste and
208 destination of unsold food). In addition to the interviews, site visits and observations were made
209 in the stores and distribution centers (DC), where photos and notes were taken to support data
210 analysis.

211 *Step 3: Data Analysis*

212 All interviews were transcribed and uploaded to the QDA Miner™ software to organize data
213 and allow for a better comparison between the cases (Hutchison et al., 2010). Data were
214 triangulated using three different sources (Yin, 2010): 47 interviews, observations from a field
215 diary, and secondary data. Before the coding process, all researchers read and discussed the
216 primary codes and their definitions (FW causes and prevention practices), resulting in a
217 codebook (shown in Table 1) to help with the data analysis. Whenever needed, codes were
218 added according to data emerging from the cases (Gibbs, 2009), which allowed the
219 identification of new FW causes and/or prevention practices. For instance, the new FW cause
220 “unpredictability of competition” (C27) refers to the price competitiveness among
221 supermarkets to attract consumers, which ends up causing FW due to the lack of demand
222 predictability. Thus, the new prevention practice of FW, namely “supplier management” (R19)
223 involves the complete management of suppliers, such as their locations, types, payment and
224 specialization.

225 The relationships among the constructs (FW causes and prevention practices) were identified
226 by using proximity of the codes throughout the text, allowing an understanding of which FW
227 causes are most often associated with the main practices to prevent them (QDA, 2017). The
228 coefficient of co-occurrence used was the Jaccard index, which gives equal weight to cases

229 where co-occurrence is identified (a); and cases where one item is found, but not the other (b)
 230 and (c). Thus, it is calculated from a quadruple table as $a / (a + b + c)$ (QDA, 2017). The content
 231 analysis of the results was carried out using a frequency analysis as a way to identify the main
 232 causes of FW.

233 Due to the high number of FW causes, the Pareto Principle was applied to identify a small
 234 number of causes (20%) that are responsible for most of the problems (80%) (Toledo et al.,
 235 2013). In other words, to identify the 20% of the causes that represented 80% of the total
 236 codification. Thus, a relationship (proximity) analysis was carried out between the selected
 237 causes of FW and the prevention practices of FW raised in the four cases. To boost reliability,
 238 we only analyzed the causes of FW and their prevention practices that appeared in at least three
 239 cases. Finally, to improve the clarity of the results, a discussion of the causes and prevention
 240 practices was held in groups according to four categories of root causes adapted from the
 241 Ishikawa Diagram (Ishikawa, 1986; Bilska et al., 2016). They are as follows: 1)
 242 Method/Management (work procedures and process measurements); 2) People (human
 243 resources involved in the process); 3) Environment (causes external to the process or
 244 organization); and 4) Technology/Material Resources (equipment, materials, and technologies).
 245 These groups were created because they generally exemplify the main sources of the causes.
 246 Table 3 shows the most frequent types of FW with their corresponding groups.

247 -----

248 Insert Table 3 about here

249 -----

250 **3. Findings**

251 Table 4 shows the relationship analysis of the most causes of FW (Table 3) and their related
 252 prevention practices of FW. The following discussion will be structured by group and by
 253 highlighting the relationship between cause and prevention practice of FW that appears in at

254 least 3 cases (code in grey in Table 4). Relationships that occurred in 2 or less cases will only
 255 be discussed if they have a relevant contribution to the aim of this study.

256 -----
 257 Insert Table 4 about here
 258 -----

259 **People**

260 In this group, highlighted in grey, we found three main relationships between FW cause and
 261 FW prevention practice. Firstly, “Incorrect handling (C16)” showed up in all four cases as a
 262 key cause of FW. This cause refers to employees’ failure to package food, how they are handled,
 263 the incorrect loading and unloading, or even overhandling of food in suppliers and supermarkets
 264 stores, specifically in transportation and in the DCs. To eliminate this cause, “Training and
 265 awareness of employees (PP14)” are carried out in all cases. This practice focuses on improving
 266 food handling and selection for display or donation. However, this does not seem to be
 267 sufficient to mitigate incorrect handling in supermarkets and suppliers, in addition to excessive
 268 handling by consumers, which reduces the shelf life of F&V even more.

269 Concerning this, the cause “Lack of training and knowledge (C14),” emphasizes the poor
 270 training, as well as a low level of knowledge and qualifications of work concerning food and
 271 waste in all cases. Interestingly, the practice “Training and awareness of employees (PP14)” is
 272 observed only within the supermarkets’ operations; therefore, excluding any efforts to include
 273 or develop suppliers. In Supermarket A (SM-A), Supermarket C (SM-C) and Supermarket D
 274 (SM-D), communication between employees and experts in food prevention allows for greater
 275 awareness of waste. However, as Supermarket B (SM-B) is a multinational company, this
 276 communication is not often and sufficient due to the large number of departments and the
 277 hierarchical distance between employees. In SM-D, unlike the other supermarkets, there is a

278 nutritionist in every store. This enables daily training, where information is provided on the
279 proper handling and storage of F&V, as well as the food selection for use in stores or donations.

280 The third cause “Lack of commitment (C15)” reflects the negligence of supermarket
281 employees regarding FW, and the practice “Training and awareness of employees (PP14)” aims
282 to prevent it in different ways, but again only for supermarket employees. For instance, SM-A
283 uses non-financial incentives, such as reduced employee workloads, to motivate employees as
284 a result of the training. According to the SM-A logistics manager, workload reductions increase
285 employee commitment by preventing overwork and decreasing fatigue, reducing mishandling
286 errors, for example. On the other hand, SM-B uses financial incentives to motivate employees
287 to keep supermarket waste within specified limits. In SM-C, a perishable food technologist
288 visits the stores and analyzes waste-producing activities, while in SM-D, having nutritionists in
289 each store improves the control and commitment of employees regarding FW. Finally, although
290 the practice “Autonomy of managers (PP15)” appears to be related to the C15 only in two cases,
291 it is worth noting that SM-A and SM-B give full autonomy to their store managers to make
292 decisions to control waste. As a result, they value this autonomy, because any increase in waste
293 levels may influence their evaluations.

294 **Method / Management**

295 In the method group, we found three main relationships between cause and FW prevention
296 practice. Firstly, “Poor inventory management (C08)” refers to difficulties in controlling food
297 coming in and out of the store, and this happens in all cases. The results of this can be even
298 worse due to the unpredictability of the amount of F&V to be displayed on the shelves.
299 Supermarkets, in general, have issues managing their inventory, as one NGO food donor
300 nutritionist pointed out:

301 This inventory issue has already happened, for example, when companies call us saying, “Oh, I have
302 so much in stock and it expires tomorrow, can you take 2 or 3 tonnes?” We can take 1% of that.

303 How am I going to distribute this to many people and consume it in a day? Some retailers can neither
304 visualize it nor prevent it from happening. [Expert-J, 2018]

305 Therefore, “Inventory management policy (PP07)” is mainly used by supermarkets to
306 monitor daily inventories to maintain enough supply and proper food stock rotation.
307 Specifically, for SM-A, the physical proximity of the DC to the stores is a factor that helps to
308 effectively manage inventories as transportation is a better option than long periods of storage.
309 In SM-B, displays are smaller and hold fewer products, which requires constantly replenishing
310 food stocks, for example, removing food from below and placing it on top, to maintain its
311 freshness. In SM-C, according to the interviews, reallocating inventory to stores in the same
312 region and using a low inventory level help to keep products moving and reduce waste. One
313 aspect of the food rotation method used by SM-D is that food unsuitable for sale due to aesthetic
314 reasons (although it is still fit for consumption) is used in the employee cafeteria, or for
315 transformation into products for sale in the store (e.g., cakes). Donations are only the last resort.

316 The second cause “Inadequate demand forecasting (C13)” appears in cases A, B and C. This
317 cause concerns both uncertainties and variations in demand, as well as in product supply. To
318 deal with this cause, all cases apply “Procedures for more accurate demand forecasting (PP12)”
319 in a different way. In SM-A, each buyer has the human assistance of a demand analyst, which
320 helps increase forecast accuracy. In SM-B, orders are placed by the purchasing and supply area,
321 and it is supported by a system that standardizes orders according to the sales history and
322 automatically schedules orders for each type of store. However, as this system is not shared
323 with suppliers, demand forecasting for F&V ends up being carried out in excel spreadsheets,
324 which reduces the possibility of achieving a more accurate (and real time) demand forecast.
325 SM-C uses a system based on sales history, which places orders according to the price and
326 quantity of F&V. However, this has not shown good practice as it normally results in many
327 errors. In these three cases (A, B, and C), their suppliers (farmers and distributors) only use data

328 from historical sales to forecast demand. On the other hand, although SM-D does not have a
 329 well-designed demand forecasting system, they normally have “Coordination and
 330 communication with members of the chain (PP10)”, such as suppliers, which helps them to
 331 obtain fairly accurate information regarding quantities to buy and sell.

332 “Lack of coordination and information sharing (C10)” refers to weak or non-existent
 333 communication and information sharing among FSC members and is related to C08. In cases
 334 A, B and C, they use “Coordination and communication with members of the chain (PP10)” to
 335 eliminate this cause, which consists of informal communication between supermarkets and their
 336 suppliers via messaging apps to exchange information about product defects and transport
 337 problems, for example. However, supermarkets SM-A, SM-B and SM-C still share very little
 338 data from their operations with suppliers, especially regarding demand.

339 Our communication is still very flawed (weak). We have evolved, but you still see that there are
 340 many flaws. It's not enough just to communicate, you have to anticipate it [Logistics manager of
 341 SM-A].

342 Although the relationship between “Retailer’s strict standards for food appearance and shape
 343 (C05)” and prevention practices occurred only in two cases or less, it is worth mentioning that
 344 this cause was observed in all cases and ends up pushing waste (and consequently, the cost of
 345 it) to other links in FSCs, such as suppliers. As a result, suppliers must find a way to redistribute
 346 F&V to other retail formats, such as wholesalers and smaller neighborhood markets, that are
 347 more flexible in terms of aesthetic standards. When this cannot happen, they end up using the
 348 rotten products as fertilizer (by throwing them into landfills) or even discarding them on
 349 highways.

350 **Technology / Material Resources**

351 Two key relationships between the causes and prevention practices of FW can be discussed
 352 in this group. “Transport equipment and storage structure problems (C02)” includes damage,

353 malfunction or absence of transport and storage products, such as inbound logistics trucks and
354 forklifts, inadequate display or insufficient space for food storage in DCs and shelves. When
355 this happens, cases A, B and C minimally adopt the practice “Development of packaging and
356 label information (PP16)”. For example, some displays in supermarkets, for instance, for
357 bananas, were changed to better exhibit the fruit and reduce waste (using hangers to avoid
358 putting the bananas on top of each other), and the use of vacuum packaging to increase the shelf
359 life of F&V. Only in case B of the three mentioned was there a collaboration between suppliers
360 (S1-B and S2-B) and SM-B to develop new packaging and displays according to the type of
361 product and the stores where they will be sold. The use of this practice in the studied cases does
362 not involve changes in food labeling.

363 “Cold chain breaking” (C01) refers to the lack of structure and equipment to maintain the
364 temperature for a long period. This cause reflects the unstable conditions of transport modes
365 and road infrastructure, as well as the large distances from all suppliers, considering Brazilian
366 geography. For example, the cantaloupes and pineapples sold in the studied supermarkets
367 mainly come from the state of Bahia. This route takes, on average, almost three days by truck,
368 where the road is unpaved and, the structure is precarious.

369 The example of pineapples that come from Bahia, when they arrive here, the fruit is great on the
370 inside, but on the outside, you see that it already has that little black bottom and there is no way of
371 avoiding it (...) today, what causes the biggest damage is this transport time, because a product
372 arrives here and it might be already 3 days old. [Logistics manager of SM-A]

373 Owing to this, cases A, B and D use “Equipment and technologies to check the food
374 condition (PP01),” such as thermometers in the trucks during transportation on Brazilian
375 highways. PP01 is also a prevention practice related to the cause “Short shelf life” (C18) as it
376 helps to monitor the freshness condition of F&V from farmers to the supermarkets. In addition,

377 cases B, C and D use cold chambers to prolong the shelf life of F&V in DCs, as well as in their
378 stores.

379 **Environment**

380 In this group, we found two main relationships between the cause and prevention practice of
381 FW. “Consumer aspects (C25)” of Brazilians that require a perfect aesthetic appearance of food
382 leads to generating a large volume of FW. This is related to people’s lifestyle, their living and
383 working conditions and social dynamics. Interestingly, it was observed that this cause only
384 affects supermarkets, which have close contact with consumers, due to their position in the
385 chain. To mitigate this cause, SM-B, SM-C and SM-D use “Secondary markets (PP03)”, in
386 which they make donations to NGOs when ugly or unshaped F&V are not sold. In contrast,
387 SM-D uses unsold food to produce items to be sold in the stores, such as cakes and jams. Despite
388 this, SM-A, SM-B and SM-C make an effort to inform consumers that food may have aesthetic
389 issues, but quality is ensured. Thus, they make an attempt to apply the prevention practice
390 “Communication with consumers (PP11)”, however communication is not frequent, and
391 consumers continue to demand high aesthetic standards, plenty of food on the shelves, and
392 squeeze the product when shopping as a way to check if the produce is good or not.

393 Brazilian consumers have a bad habit of touching products, handling (...). [Expert A].

394 **4. Discussion**

395 This section discusses the empirical findings of this research (Tables 3 and 4) against the
396 literature. Findings regarding people’ actions to prevent waste (People Group) are mostly
397 related to the prevention practice of employee training and awareness, which occurred in all
398 cases and is related to three different causes of the same group. As a way to increase employee’s
399 engagement in training, supermarkets use different sets of financial (such as when a specific
400 waste target is met) and non-financial incentives (such as reduction workloads to reduce fatigue
401 and increase attention to operations). Although the use of these non-financial incentives was

402 not found in the literature, it showed to be an effective way to prevent the FW causes related to
403 'people'.

404 In addition, qualified store employees (such as nutritionists) facilitate training and employee
405 awareness of waste prevention, considering that these professionals have a clear understanding
406 of the sanitary standards and nutritional characteristics of foods. The presence of these
407 nutritionists in supermarkets was not observed in the literature as a factor that can help prevent
408 waste; only the experience and knowledge of store managers (Gruber et al., 2016; Teller et al.,
409 2018). Despite being a beneficial practice, only supermarkets use this practice without making
410 efforts to involve suppliers in it. Thus, training is provided exclusively for supermarket staff,
411 decreasing the chance of waste prevention in suppliers. The literature has suggested extending
412 these activities to other members of FSCs (Göbel et al., 2015; Derqui et al., 2016), which would
413 be useful in reducing errors related to handling and storage of food, from harvest to
414 supermarkets. However, this was neither found in the cases analyzed (due to the lack of
415 collaboration and actions related to it) nor mentioned by the experts. Training has proven to be
416 an effective way to increase employee's knowledge (Gruber et al., 2015), however in the
417 Brazilian cases, only training has not been enough to prevent food waste. One of the reasons is
418 the high turnover of employees in Brazilian supermarkets, which consequently impacts the lack
419 of commitment (C15) as supermarkets typically demonstrate minimal effort in providing
420 knowledge to their employees.

421 Regarding the Method/Management Group, self-interest behavior was strongly observed in
422 the supermarkets, in which they mainly made efforts to reduce the cost of waste only in their
423 own operations (stores and DC). Due to this, supermarkets do not provide sufficient support to
424 suppliers in preventing their own waste by coordinating joint actions, for instance. Instead, they
425 sometimes push waste by returning products that do not fit their expectation in terms of
426 aesthetic aspects. Their actions are normally focused on improving their own internal operations

427 to eliminate local FW causes. This type of discussion has already been reported in the literature
428 (Mena et al., 2011; Teller et al., 2018; Diaz-Ruiz et al., 2019) and was validated through the
429 cases studied in Brazil. In other words, this seems to be a common behavior observed in
430 supermarkets around the world.

431 Despite the role of supermarkets in coordinating FSCs and disseminating innovations
432 through them (Gruber et al., 2015; Cicatiello et al., 2016; Brancoli et al., 2017), we found that
433 supermarkets do not share information (especially related to sales, inventory, technologies, and
434 waste data) with the upstream or downstream actors; which is an action that reaffirms the
435 supermarkets' self-interest behavior. Although there is a clear relationship between the "Lack
436 of coordination and information sharing" and the practice "Coordination and communication
437 with members of the chain", it is under explored by the dyad. The studied supermarkets are not
438 proactive in dealing with FW, especially when FW prevention practices require coordination
439 with other members of the chains.

440 This self-interest is also strengthened by poor coordination and communication among the
441 chain members. Some supermarkets exchange information through apps with store managers
442 and specific suppliers, but the real intention of this action is only to mitigate issues that will
443 directly impact supermarkets' operations (e.g., lack of merchandise on supermarket shelves)
444 rather than result to a beneficial outcome for the entire supply chain (e.g., helping suppliers to
445 prevent FW). Likewise, in the literature, supermarkets exchange little information with their
446 suppliers about demand forecasting (Kaipia et al., 2013; Bustos; Moors, 2018). Thus, open
447 access to key demand and supply information between this dyad would help them plan
448 operations, and consequently prevent FW.

449 Regarding "retailer's strict standards of food appearance and shape", supermarkets have
450 been flexible during times of product shortages (e.g., off-season periods) and accepted products
451 that are below the required quality standards. However, undernormal conditions, supermarkets

452 take a strong negotiating position with suppliers, who end up with the most FW. Reynolds et
453 al. (2018) cite this situation as an unfair trading practice (UTP), which occurs due to power
454 imbalances among actors; this is particularly prevalent due to the market concentration of a
455 handful of large retailers. This can result in unpredictable changes of contract terms that may
456 lead to overproduction and result in unnecessary food waste. In addition to the commercial
457 impact, this action mainly affects smaller producers, as is the case of some suppliers in this
458 study. Soma et al. (2021) points out that the impact of these types of decisions negatively affects
459 the farm practices and the factors that influence them, many of which are out of their control.

460 Regarding waste measurements, supermarkets and suppliers account for these in different
461 and non-continuous ways, as they have different interests and culture. Consequently, waste
462 measures differ from one store to another within the same FSC. For example, in SM-B, the
463 quantity of food wasted is not regularly measured and consequently does not follow a standard
464 procedure. Thus, the values disclosed by the interviewees of this supermarket are different in
465 the same store format. According to Cicatiello and Franco (2020), regular food waste
466 accounting can sometimes be considered the first form of FW prevention in the retail sector.

467 In the cases studied, the FW prevention practice “pricing and promotion policies” is related
468 to the cause of “lack of control in orders” and appears in only two cases. It is worth mentioning
469 that to keep pace with competitors’ prices and promotions, supermarkets lower their prices
470 (previously set based on demand forecasts) in an attempt to reduce the waste of purchased food.
471 As identified by Soma et al. (2021), this practice can lead to overconsumption for consumers
472 and push waste from the supermarket to the consumer. On these occasions, supermarkets
473 negotiate lower prices with suppliers, including the waste rate, because the suppliers do not
474 want the F&V to be returned. These returns, which are called “take-back agreements” in the
475 literature, have a knock-on effect in the supply chain and boost even more FW. As in Eriksson
476 et al. (2017), in the cases studied, F&V considered inappropriate are returned, however as

477 supermarkets determine the quality and appearance, they wish to receive from these foods,
478 posing a risk of categorizing unsold F&V as inadequate quality and returning them to suppliers.
479 However, unlike Eriksson et al. (2017), these take-back agreements also occur due to
480 competition from local supermarkets (such as SM-A and SM-C), which require a F&V price
481 war to attract customers. Any change (as in the case of competitor prices) can impact the
482 scheduled orders, and consequently, generate FW.

483 Regarding the Technology / Material Resources Group, our field research shows that there
484 is a difference in the technological level between the literature and empirical cases. In the
485 literature, a variety of advanced technologies and packaging was reported to prevent waste
486 (such as smart packaging with sensors and modified atmosphere) (Jedermann et al., 2014,
487 Verghese et al., 2015, Raak et al., 2017, Wikström et al., 2019). The difference between
488 examples of packaging in the literature (mostly from developed countries) and those in the
489 current empirical cases is mainly due to the cost of adopting it in Brazil. Only simple
490 adjustments to packaging and displays were identified in the cases, and they do not help in a
491 way that could prevent waste in Brazil. Although suppliers and supermarkets know about these
492 useful technologies, they are not willing to make the investment, as they do not see the return
493 as valuable. This is due to the high cost of adoption, lack of interest, and the lack of regulatory
494 compliance. Regarding the packaging aspect, there are no discussions about expiration dates
495 (best-before date) in Brazil. In developed countries, these discussions (Verghese et al., 2015,
496 Thyberg; Tonjes, 2016, Canali et al., 2017) are slightly more advanced and allow for better
497 communication with consumers and also facilitate donations.

498 The “Equipment and technologies to check food condition” are also different in Brazilian
499 cases, especially when related to the cause “Cold chain breaking”. The reported equipment is
500 not sufficient to maintain the temperature of food due to the lack of quality of this equipment
501 and the distance between some suppliers and the DC of supermarkets. For example, SM-B,

502 which has several stores throughout Brazil, centralizes most of the products on the DC in São
503 Paulo. Thus, F&V often travel a long distance on highways with little infrastructure and
504 equipment that does not maintain the temperature.

505 Concerning the Environment Group, when low supply situations occur due to weather events
506 and seasonality, the supermarkets use the practice “flexibility of quality standards” to decrease
507 quality standards; this has also been demonstrated in the literature (Mena et al., 2011; Göbel et
508 al., 2015; Canali et al., 2017; Teller et al., 2018) and was validated through the cases studied in
509 Brazil. Under normal conditions, F&V that do not meet the quality standards imposed by the
510 supermarket and consumers are typically rejected and pushed back to suppliers.

511 Although communication with consumers was highlighted as a practice in the literature
512 (Richter and Bokelmann, 2016, Muriana, 2017) to raise people’s awareness of FW issues
513 (Malefors et al., 2022), in Brazilian cases this was not observed. The three cases that used this
514 practice to prevent the cause of consumer aspects do not use it as recommended in the literature.
515 A lack of awareness on the subject in Brazilian supermarkets is noticeable. Consequently, little
516 investment is made in communication with consumers. This practice is difficult to implement
517 due to the Brazilian culture of abundance, pointed out by Henz and Porpino (2017) and
518 consumers’ habit of always overhandling F&V before buying the products, accelerating their
519 maturation and following waste. According to the interviews, full supermarket displays can
520 boost sales despite increasing waste. Thus, supermarkets continue to encourage the culture of
521 abundance rather than implementing communication with consumers to make them aware of
522 the waste of these actions.

523 Moreover, due to the poor Brazilian road infrastructure, large transportation distances
524 between the 26 states and the Federal District, problems in cold chains, and lack of legislative
525 inspection, supermarkets in Brazil prefer to discard food as there are no legal penalties, rather
526 than investing in prevention or donation. The cause of “restrictive laws” (Gruber et al., 2016

527 Priefer et al., 2016) was not highlighted by the cases as a major problem as they are not aware
528 of this need. In addition, the laws for food donations implemented in Brazil do not encourage
529 supermarkets or any retailers to make donations, even sporadically. In contrast, this does not
530 happen in supermarkets in France and Italy, where there are tax incentives and laws that force
531 supermarkets to donate surplus food to NGOs (Global Citizen, 2016; The Guardian, 2016). This
532 cultural and legal disparity in Brazil leads to a different discussion of the causes and prevention
533 practices of FW from what it is known in the current literature.

534 **5. Conclusion**

535 This research investigated the main causes of FW (specifically fruit and vegetables) and their
536 relationship with prevention practices at the supermarket and suppliers' level. It is important to
537 note that the causes and prevention practices of FW discussed in this paper are typical of F&V
538 products and may not be relevant for other food categories. Overall, our findings suggest that
539 differently from what the literature points out, the retail has the power to promote change
540 throughout the chain, providing leadership, education and information sharing; in this study, in
541 terms of food waste, this neither happens or is exclusively to supermarket internal operation.
542 Supermarkets can improve their own practices and behavior to focus their efforts on preventing
543 FW throughout FSC, rather than just in their internal operations. In addition, supermarkets and
544 suppliers could visualize a way to overcome limitations regarding legislation, technology and
545 cultural issues, similar to Brazil, by being aware of different practices applied to other countries.

546 Key findings/contributions can be taken from this research. With regards to the "People"
547 aspect, the study found that incorrect handling, lack of commitment and poor training are causes
548 of FW that can be beaten through effective training that can provide knowledge and skills,
549 besides investing in employee development to motivate them and reduce turnover rates, as well
550 as involving suppliers in training. Regarding "Method / Management" aspect, poor inventory
551 management, inadequate demand forecast, lack of coordination and information sharing and

552 aesthetic aspects are causes of FW that can be mitigated by: 1) developing collaboration
553 between supermarkets and suppliers so as to share accurate and real time information to better
554 align demand; 2) choosing frequent and low quantity of fresh F&V in delivery and on the
555 shelves; 3) working on consumer behavior to show them the importance of nutrition over
556 aesthetic aspects of F&V; in doing so, supermarkets can be more flexible in accepting and
557 selling unshaped food.

558 On “Technology / Material Resources” aspect, transport equipment and storage structure
559 problem, and cold chain breaking are causes that can be minimized by collaboratively working
560 with suppliers to develop packaging and labelling solutions, as well as using technologies to
561 monitor and prevent FW through transportation. Regarding the “Environment” aspect, the
562 consumption aspect, is a cause unlikely to be changed in the short term, as highlighted above
563 in the Method group. In the studied cases it had a particular and negative impact due to the
564 Brazilian culture of abundance and the habit of overhandling F&V before buying it. Working
565 on this issue would require campaigns to show consumers the impact of their behavior. The
566 result of the campaigns will have an upstream knock-on effect as: supermarkets will become
567 more flexible in accepting non-standard F&V while adopting prevention practices to prevent
568 FW (such as donation); suppliers can develop a list of second markets to sell food still suitable
569 for consumption before sending them to landfills. Efforts can be made from the government to
570 create legislation to motivate FSC companies to take their actions seriously to prevent FW.

571 This research addressed the problem of food waste in the supplier-supermarket dyad, which
572 in addition to having high levels of FW, is an important focus of study, because retailers have
573 so much power to influence what happens at the consumer level and the farm level. As
574 theoretical contributions, this study identified the main root causes of FW and provided a list
575 of prevention practices that supermarkets and suppliers can benefit from. Managerially, it can
576 help managers spot the causes of FW within their operations, and hence change, improve or

577 implement practices and behavior to prevent FW. Despite the cases studied in this research,
578 being from an emerging country and having cultural and regulatory specificities that influence
579 the behavior of consumers and the dyad, globally supermarkets have similar practices to deal
580 with FW. . In other similar studies such as Mena et al. (2011) and Teller et al. (2018), the lack
581 of collaboration and exchange of information with suppliers was also found, but they have a
582 similar and important role in the chain to prevent food waste, regardless of the country.

583 As with all empirical research, the limitations of our study may stimulate further research.
584 This paper only analyzes some relationships between causes and prevention practices of FW,
585 which are important to evaluate the other possible relationships and measure the efficiency of
586 all of these in all groups. The emphasis of this research was on the supermarket sector and
587 suppliers, but future studies could also analyze the relationships between the same variables
588 (causes and prevention of FW) in other retail formats, such as home delivery and click-and-
589 collect, as part of the online retail distribution, as well as in other regions of Brazil as each state
590 has its own legislation, climatic and cultural aspects).

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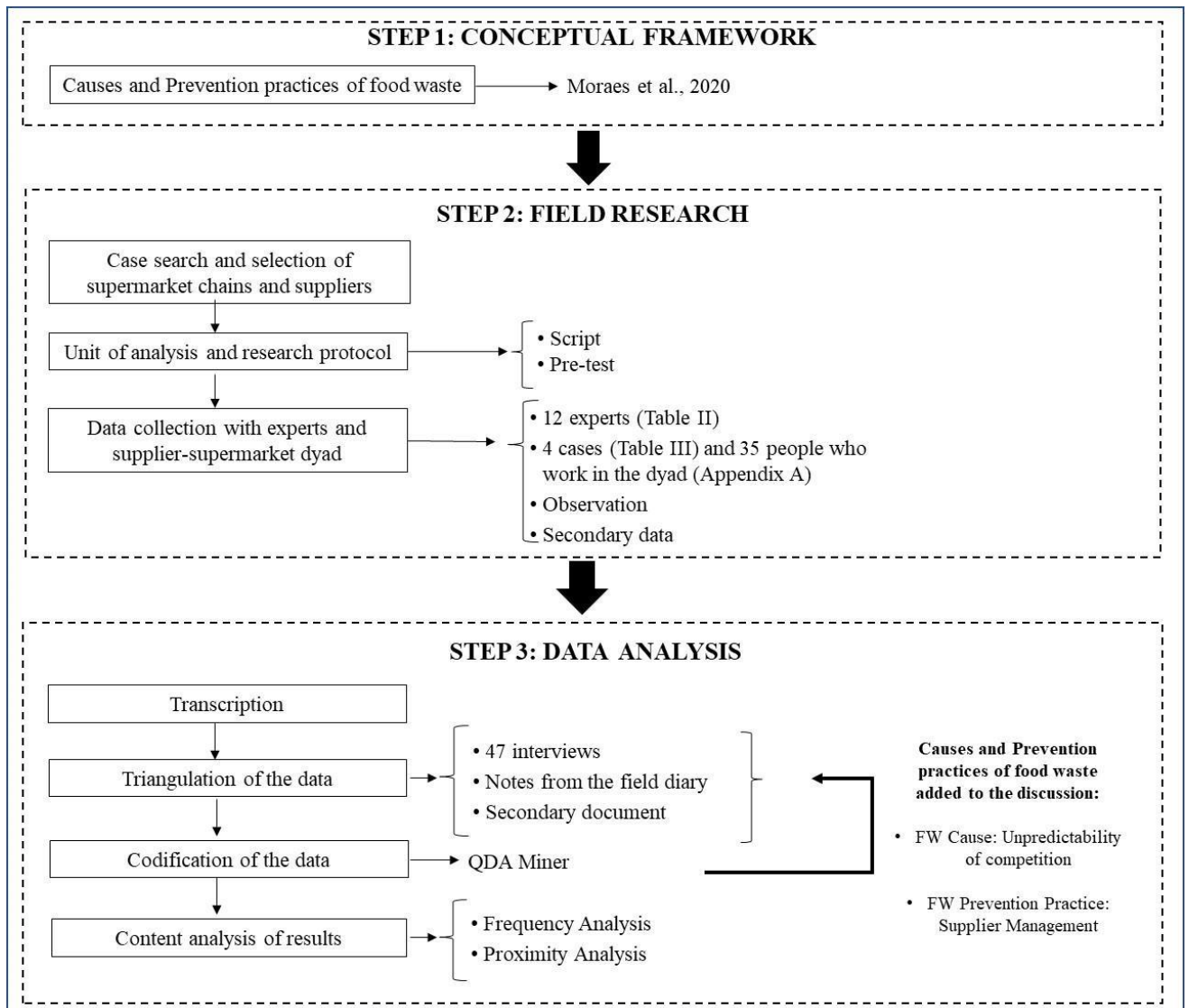
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Figure 1 – Steps in the research



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Table 1 – Causes and prevention practices of FW

CAUSES (C) OF FW	PREVENTION PRACTICES (PP) OF FW
● C01 - <i>Cold chain breaking</i> (Priefer et al., 2016; Mena et al., 2014)	● PP01 - <i>Equipment and technologies to check food conditions</i> (Jedermann et al., 2014; Tromp et al., 2016; Mena et al., 2011; Thyberg and Tonjes, 2016)
● C02 - <i>Transport equipment and storage structure problem</i> (Cicatiello et al., 2016; Garrone et al., 2014)	● PP02 - <i>Flexibility of quality standards</i> (Canali et al., 2017, Garrone et al., 2014; Göbel et al., 2015).
● C03 - <i>Lack of integrated IT systems for food tracking</i> (Balaji and Arshinder, 2016)	● PP03 - <i>Secondary markets</i> (Aiello et al., 2015; Beretta et al., 2013).
● C04 - <i>Inappropriate work procedures</i> (Balaji and Arshinder, 2016; Bilska et al., 2016)	● PP04 - <i>Pricing and promotion policies</i> (Tromp et al., 2016; Liljestrand, 2017; Holweg et al., 2016; Aschemann-Witzel, 2018; Reynolds et al. 2018).
● C05 - <i>Retailer's strict standards of food appearance and shape</i> (Canali et al., 2017; Göbel et al., 2015; Mena et al., 2011)	● PP05 - <i>Own brands</i> (Mena et al., 2011).
● C06 - <i>Lack of definition of responsibility at work</i> (Gruber et al., 2015; Mena et al., 2011).	● PP06 - <i>Dissemination of quality policies in the company</i> (Bilska et al., 2016)
● C07 - <i>Non-compliance with food safety and quality standards</i> (Balaji and Arshinder, 2016; Priefer et al., 2016)	● PP07 - <i>Inventory management policy</i> (Jedermann et al., 2014; Liljestrand, 2017; Strotmann et al., 2017)
● C08 - <i>Poor inventory management</i> (Balaji and Arshinder, 2016); Canali et al., 2017; Holweg et al., 2016)	● PP08 - <i>Integrated logistics system</i> (Thyberg and Tonjes, 2016)
● C09 - <i>Lack of collaboration</i> (Aiello et al., 2015; Derqui et al., 2016)	● PP09 - <i>Collaboration</i> (Derqui et al., 2016)
● C10 - <i>Lack of coordination and information sharing</i> (Balaji and Arshinder, 2016; Raak et al., 2017; Cicatiello et al. (2020)	● PP10 - <i>Coordination and communication with members of the chain</i> (Liljestrand, 2017; Mena et al., 2011)
● C11 - <i>Poor logistics network design</i> (Balaji and Arshinder, 2016; Holweg et al., 2016)	● PP11 - <i>Communication with consumers</i> (Muriana, 2017)
● C12 - <i>Lack of control in orders</i> (Bilska et al., 2016, Mena et al., 2011)	● PP12 - <i>Procedures for a more accurate demand forecasting</i> (Göbel et al., 2015, Derqui et al., 2016 and Strotmann et al., 2017)
● C13 - <i>Inadequate demand forecasting</i> (Balaji and Arshinder, 2016; Mena et al., 2011; Tromp et al., 2016)	● PP13 - <i>Reduction-focused integrated operational systems</i> (Thyberg and Tonjes, 2016)
● C14 - <i>Lack of training and knowledge</i> (Balaji and Arshinder, 2016; Bilska et al., 2016)	● PP14 - <i>Training and awareness of employees</i> (Derqui et al., 2016; Gruber et al., 2015)
● C15 - <i>Lack of commitment</i> (Gruber et al., 2015)	● PP15 - <i>Autonomy of managers</i> (Gruber et al., 2015)
	● PP16 - <i>Development of packaging and label information</i> (Raak et al., 2017, Thyberg and Tonjes, 2016; Priefer et al., 2016; Beitzen-Heineke et al., 2017)

<ul style="list-style-type: none"> • C16 - <i>Incorrect handling</i> (Balaji and Arshinder, 2016; Mena et al., 2011) • C17 - <i>Problems with packaging and labeling</i> (Balaji and Arshinder, 2016; Mena et al., 2014; Tromp et al., 2016). • C18 - <i>Short shelf life</i> (Garrone et al., 2014; Tromp et al., 2016) • C19 - <i>Climate and phytosanitary aspects</i> (Mena et al., 2011; Gruber et al., 2015) • C20 - <i>Food polemics</i> (Göbel et al., 2015; Gruber et al., 2015) • C21 - <i>Restrictive laws</i> (Gruber et al., 2015; Priefer et al., 2016) • C22 - <i>Excessive stakeholder pressure</i> (Canali et al., 2017; Derqui et al., 2016) • C23 - <i>Seasonality</i> (Mena et al., 2011; Mena et al., 2014) • C24 - <i>Lack of waste measurement</i> (Derqui et al., 2016). • C25 - <i>Consumer aspects</i> (Hermsdorf et al. 2017; Teller et al. 2018). • C26 - <i>Store location</i> (Ribeiro et al., 2019). 	<ul style="list-style-type: none"> • PP17 - <i>Flexibilization of laws without compromising consumer health</i> (Canali et al., 2017, Priefer et al., 2016, Gruber et al., 2015) • PP18 - <i>Use of technologies for measuring waste</i> (Priefer et al., 2016; Strotmann et al., 2017)
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Table 2 – Information about the cases

Case	Companies	Company time in the sector (in years)	Additional information
Case A	SM-A	> 30	<ul style="list-style-type: none"> • 20 stores – only medium format • National and regional company • Sao Paulo state • 1 Distribution Center (DC) and its own transport • Orders are placed by the Purchasing area and delivered every day • One nutritionist for all stores
	S1A	> 20	Leafy producer and has worked with the supermarket for 18 years.
	S2A	> 20	Broccoli producer and has worked with the supermarket for 4 years.
Case B	SM-B	> 40	<ul style="list-style-type: none"> • 400 stores in Brazil – small, medium and hypermarket format • Multinational company • All over Brazil • 15 DC and outsourced transport • Orders are placed by the Purchasing and Supply area • One nutritionist in some stores and a loss prevention school
	S1B	> 20	F&V distributor and has worked with the supermarket for 8 years.
	S2B	> 60	National and imported fruit distributor and has worked with the supermarket for 10 years.
Case C	SM-C	> 50	<ul style="list-style-type: none"> • 15 stores – only medium format • National and regional company • Sao Paulo state • Newly built DC • Orders are placed by the Purchasing area and store managers • One nutritionist and a perishable technician for all stores
	S1C	> 50	Fruit distributor and has worked with the supermarket for 20 years.
	S2C	>50	Banana producer and distributor of tubers, and has worked with the supermarket for 46 years.
Case D	SM-D	> 60	<ul style="list-style-type: none"> • 15 stores – hypermarket format • National and regional company • Santa Catarina state • 1 DC • Orders are placed by the Purchasing area and delivered to the DC or stores • One nutritionist in each store
	S1D	> 20	Vegetable distributor and has worked with the supermarket for 20 years.
	S2D	> 20	Fruit distributor and has worked with the supermarket for 20 years.

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Notes: DC: Distribution center

SM-A: Supermarket A; **SM-B:** Supermarket B; **SM-C:** Supermarket C; **SM-D:** Supermarket D.

S1A: Supplier 1 of Supermarket A; **S2A:** Supplier 2 of Supermarket A;

S1B: Supplier 1 of Supermarket B; **S2B:** Supplier 2 of Supermarket B;

S1C: Supplier 1 of Supermarket C; **S2C:** Supplier 2 of Supermarket C;

S1D: Supplier 1 of Supermarket D; **S2D:** Supplier 2 of Supermarket D.

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896**Table 3** – Most frequent causes of FW found in cases and their corresponding groups

FREQUENCY RANKING	CAUSES OF FW	GROUPS*				CASES				TOTAL
		M/M	P	E	T/M	A	B	C	D	
1	Inadequate demand forecasting (C13)	X				7	9	7	5	28
2	Transport equipment and storage structure problem (C02)				X	5	11	5	5	26
3	Retailer's strict standards of food appearance and shape (C05)	X				7	9	5	5	26
4	Climate and phytosanitary aspects (C19)			X		6	5	6	6	23
5	Non-compliance with food safety and quality standards (C07)	X				5	7	4	6	22
6	Cold chain breaking (C01)				X	6	8	5	3	22
7	Consumer aspects (C25)			X		4	7	5	5	21
8	Poor inventory management (C08)	X				6	6	4	4	20
9	Incorrect handling (C16)		X			3	7	5	5	20
10	Short shelf life (C18)				X	3	8	3	6	20
11	Lack of coordination and information sharing (C10)	X				6	7	4	2	19
12	Lack of control in orders (C12)	X				4	5	5	2	16
13	Lack of commitment (C15)		X			5	7	2	2	16
14	Inappropriate work procedures (C04)	X				5	6	2	2	15
15	Lack of training and knowledge (C14)		X			3	8	3	1	15

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Table 4 - Proximity analyses between causes and prevention practices OF FW in groups

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GROUP	CAUSES (C) OF FW	PREVENTION PRACTICES (PP) OF FW	CASE A	CASE B	CASE C	CASE D
People	Incorrect handling (C16)	<i>PP14 - Training and awareness of employees</i>	■	■	■	■
		PP16 - Development of packaging and label information		■		
	Lack of training and knowledge (C14)	<i>PP14 - Training and awareness of employees</i>	■	■	■	■
		PP15 - Autonomy of managers	■	■		
Lack of commitment (C15)	<i>PP14 - Training and awareness of employees</i>	■	■	■	■	
	PP07 - Inventory management policy	■	■	■	■	
Method / Management	Poor inventory management (C08)	PP15 - Autonomy of managers		■		■
		PP08 - Integrated logistics system	■			
		PP14 - Training and awareness of employees			■	
		PP10 - Coordination and communication with members of the chain			■	
	Inadequate demand forecasting (C13)	<i>PP12 - Procedures for a more accurate demand forecasting</i>	■	■	■	
		PP10 - Coordination and communication with members of the chain			■	■
		PP08 - Integrated logistics system		■		
	Lack of coordination and information sharing (C10)	<i>PP10 - Coordination and communication with members of the chain</i>	■	■	■	
		PP12 - Procedures for a more accurate demand forecasting	■		■	
		PP09 – Collaboration		■		
		PP08 - Integrated logistics system	■			
	Retailer’s strict standards of food appearance and shape (C05)	PP15 - Autonomy of managers	■			
		PP02 - Flexibility of quality standards	■	■		
		PP19 - Supplier management	■		■	
		PP10 - Coordination and communication with members of the chain	■		■	
	Lack of control in orders (C12)	<i>PP03 - Secondary markets</i>		■		
		PP04 - Pricing and promotion policies	■	■		
		PP12 - Procedures for a more accurate demand forecasting		■		
		PP09 – Collaboration	■			
		PP10 - Coordination and communication with members of the chain	■			
PP13 - Reduction-focused integrated operational systems		■				
PP19 - Supplier management				■		
Technology / Material Resources	Transport equipment and storage structure problem (C02)	PP08 - Integrated logistics system			■	
		<i>PP16 - Development of packaging and label information</i>	■	■	■	
		PP01 - Equipment and technologies to check food conditions	■	■		
		PP08 - Integrated logistics system		■		
		PP07 - Inventory management policy		■		
	PP18 - Use of technologies for measuring waste				■	
Cold chain breaking (C01)	<i>PP01 - Equipment and technologies to check food conditions</i>	■	■		■	
	PP08 - Integrated logistics system		■			

Environment	Short shelf life (C18)	PP18 - Use of technologies for measuring waste				■	
		<i>PP01 - Equipment and technologies to check food conditions</i>		■	■	■	
		PP07 - Inventory management policy		■			
		PP08 - Integrated logistics system		■			
		PP15 - Autonomy of managers	■				
		PP03 - Secondary markets	■				
	Consumer aspects (C25)	<i>PP03 - Secondary markets</i>			■	■	■
		<i>PP11 - Communication with consumers</i>	■	■	■		
		PP14 - Training and awareness of employees		■			
		PP18 - Use of technologies for measuring waste			■		
		PP16 - Development of packaging and label information					■
		Climate and phytosanitary aspects (C19)	PP02 - Flexibility of quality standards	■	■		
PP04 - Pricing and promotion policies	■					■	
PP19 - Supplier management	■						
PP12 - Procedures for a more accurate demand forecasting	■						

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