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1

2 **Towards more Sustainable Food Systems**

3 **Addressing Food waste at school canteens**

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7

8 **1. Introduction**

9

10 Reducing food waste is considered one of the most promising measures to improve food security in the coming
11 decades (Kummu et al., 2012). Indeed, up to one third of the food produced for human consumption globally is
12 estimated to be wasted or lost, not reaching its original purpose (Östergren et al., 2014). In developed countries,
13 waste occurs mostly at the distribution and consumption stages of the supply chain, and this is very closely related
14 to shortcomings such as buying or cooking excess food, deficient storage conditions (Principato, Secondi, & Pratesi,
15 2015), or undervaluing food (Finn, 2014). Indubitably, schools have a relevant role to play in educating future
16 consumers. Lunch patterns, including food waste at school canteens, will probably influence future consumer
17 habits regarding sustainability. Food waste can also be seen as a particularly significant issue in schools because it
18 probably means that children are not gaining the nutritional benefit of the wasted food (Wrap, 2011). This is
19 especially disquieting in the present context in which new risks for our global health situation are emerging
20 (Mathijs, 2012): obesity and overweight rates are rapidly increasing in almost all developed countries, especially
21 among children (Belot & James, 2011). Schools provide a key avenue to both preventing and reducing the
22 prevalence of childhood overweightness (Jacko,Dellava,Ensle & Hoffman, 2007) as well as helping to improve habits
23 on nutrition, through education on nutritional values and increasing awareness on food relevance (Benvenuti, De
24 Santis, Santesarti, & Tocca, 2016).

25 In fact, school cafeterias are very much a controlled environment where educational campaigns offer unique
26 opportunities, which could be incorporated into existing curricula in order to minimise food waste, divert this food
27 waste from landfills, and transform waste materials into energy and soil amendments through composting or
28 anaerobic digestion, etc. (Wilkie, 2015). On the other hand, in the current global trend towards greener schools,
29 managers are in search of strategies and interventions that improve the sustainability of all school operations,
30 while, at the same time, sustainability issues are being included in school curricula.

31 The goal of this research is to describe drivers that contribute to food waste at schools as well as to identify
32 strategies that could lead to its reduction. To do this we conducted an explorative mixed method research
33 approach: we started with 12 in-depth interviews among managers and staff of different institutions that play a
34 role in school meals; then we directly measured waste from over 10.000 trays in four schools in Barcelona. At the
35 end of this study we now hold useful information regarding the feasibility of implementing different interventions
36 in order to improve the sustainability of school food systems. This will be useful for school managers as well as for
37 food service and catering corporations in their process of planning their corporate sustainability strategies and
38 even their marketing plans.

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42 **2. School Food Environment**

43 Consumption patterns are of great concern since they dictate the shape of the global food production system
44 (Benvenuti et al., 2016). This is particularly relevant when talking about children, whose consumption habits will
45 frame the future of the food supply chain. On the one hand, school age children are vulnerable to nutritional
46 imbalance and, on the other hand, they are especially receptive to nutritional education (Perseo, 2008). Nutritional
47 habits established at childhood will probably last lifelong. Remarkably, research findings strongly support that the
48 risk for adult obesity for a child who is overweight is great because most overweight children become overweight
49 adults (Jacko, Dellava, Enslie & Hoffman, 2007). In addition, tradition ("*I have always been taught to eat everything*
50 *on my plate*") was mentioned by Miroso (2016, p. 8) as a key driver for lower food waste levels. Therefore,
51 education with relation to food, nutrition and waste at school becomes crucial. At the same time, due to an
52 increasing employment of mothers, a large share of children has to eat lunch at school.

53 Most European countries currently have their own national school food policy which either regulates through
54 mandatory standards or gives voluntary guidance on topics such as child nutrition or education on healthy diets, in
55 order to guarantee healthy nutrition and prevent obesity (Storcksdieck genannt Bonsmann, 2014). On the other
56 hand, children's nutritional intake has repeatedly been the topic of public concern as well as of research. Needless
57 to say, a perfectly nutritionally designed menu is useless if food is left over. This becomes particularly critical when
58 we consider different food types, as leftovers are often the healthiest plates (Betz, Buchli, Göbel, & Müller, 2015);
59 vegetables and fruits are too often disliked or rejected by kids.

60 Typically, schools have contractual agreements with catering companies and therefore quite a few players are
61 involved - directly or indirectly - in the generation of food waste at schools: students, professors, catering
62 employees and parents (Cross & MacDonald, 2009). Catering operations are influenced by different policies at all
63 levels and must accomplish with safety, hygiene, health, procurement, waste management and other regulations
64 on top of being at the same time often under consistent economic pressure (Goggins & Rau, 2015). Yet, within the
65 food service sector, catering professionals, food procurement officials and chefs are in positions of responsibility
66 and influence as they continually make decisions that help to shape, guide and control the food system (Goggins &
67 Rau, 2016). Additional research is needed about how to maximise the role of school nutrition services staff and
68 enhance collaboration with administrators, teachers, and parents in carrying out school-based interventions
69 towards sustainability (Slawson et al., 2013).

70

71 **3. Relevance and visibility of Food Waste in the school environment**

72 Although it is widely acknowledged that food wastage occurs along the whole food supply chain (Betz et al., 2015),
73 there is an insufficient insight into how much food is wasted in companies and institutions and this makes it difficult
74 to develop strategies and prioritise actions to fight against it (World Resources Institute, 2016). Moreover, the lack
75 of visibility on food waste makes managers underestimate its relevance, therefore not focussing on its reduction
76 (Derqui, Fayos, & Fernandez, 2016).

77 This said, the amount of food wasted at schools has been the object of numerous studies, which have shed light on
78 the relevance of addressing this topic at school canteens. Striking results have been obtained by researchers such
79 as Byker (2014), who computed that 45.3% of total food served to students in a school in the US was wasted; or
80 Bergman (2004), whose study showed that between 18.9% and 28.5% of calories offered were finally wasted.
81 Whatley (1996) had also concluded that children consumed approximately 25% less energy than served. Other
82 researchers have estimated waste by food type (e.g. Byker et al., 2014; Marlette, Templeton, & Panemangalore,
83 2005; Smith & Cunningham-Sabo, 2014), reaching similar results: over 40% fruit and over 30% vegetables served
84 were finally wasted by students during the period studied by the cited authors.

85 Surprisingly, despite these striking figures, a survey among cafeteria managers in the US in 1996 showed that 55%
86 of them perceived food waste as “little or no problem” (US General Accounting Office, 1996), possibly as a result of
87 the low visibility of food waste in food service institutions (Derqui *et al.*, 2016). Interestingly, cafeteria managers
88 within this US 1996 study were more likely to report that plate waste was at least a moderate problem than did
89 school managers, probably due to being closer to where waste is produced.

90 By reducing food waste, schools can clearly be contributors to a more sustainable food system. Moreover, as stated
91 by the US Environmental Protection Agency (EPA), they can reduce costs at the same time (EPA, 2014). Cohen et al
92 (2013) estimated that food represents about 44% of the total meal cost and estimated waste cost in Boston middle
93 schools at 26.1% of the total food budget. Needless to say, reducing food waste would imply a reduction of this
94 relevant cost. This is of significant importance as decision makers may consider social and environmental
95 dimensions of sustainability as secondary (Bansal, Pratima; Roth, 2000), while they prioritise the economic
96 dimension of food waste which is often hidden (Mena, Adenso-Diaz, & Yurt, 2011), thus increasing visibility through
97 waste audits should be the first step towards reducing waste (Boschini et al., 2017).

98

99 **4. Food Waste drivers at school canteens and recommended interventions**

100 Too often food is prepared but not served or served but not eaten (Wrap, 2011). This may include losses during
101 preparation and cooking, discards due to preparation of too much food, expired use-by or open dates, spoilage as
102 well as plate waste (Clarke, Schweitzer, & Roto, 2015). Several studies in the food service industry (e.g. Betz et al.,
103 2015; Silvennoinen et al., 2012) have highlighted the relevance of plate waste for the fact that it was found to be
104 the highest source of waste in this channel. Moreover, they state that plate waste is mostly avoidable (Betz et al.,
105 2015). Causes of plate waste described include variation on student energy needs and appetites, meal likes and
106 dislikes, scheduling constraints or inadequacy and availability of foods from competing sources (Buzby & Guthrie,
107 2002).

108 Reasons for food waste at schools identified by the UK's Waste and Resources Action Programme (2011) were
109 grouped into three categories: 1) Behavioural drivers, related to individual choices and preferences; 2) Operational,
110 including those drivers related to catering provider policies and to systems at a school level, and 3) Situational,
111 factors related to broader issues not directly connected to food, such as rushed lunch hours or canteen
112 environment.

113 Although acknowledging that people have different rates of willingness to waste (Wilson, Rickard, Saputo, & Ho,
114 2017), behavioural drivers are likely to be modified through educational or awareness campaigns. In fact, Yoon and
115 Kim (2012) carried out research on students' perceptions on food waste concluding that elementary school
116 children's attitudes towards food waste were significantly negatively correlated with plate waste rates and
117 therefore strongly recommended nutrition education as the way to reduce food waste. Williams *et al.* (2012)
118 reported that individuals with high environmental awareness were likely to waste less food. Furthermore, Miroso
119 et al. (2016) related this fact to the personal value of universalism (care for the welfare of all and for nature),
120 indicating that individuals who care for others and the environment are less likely to waste food. They also highlight
121 the fact that people feel guilty when they waste food. Tangible (e.g. stickers) or non-tangible rewards (praise) were
122 suggested effective by Cooke et al. (2011) in easing children's acceptance of healthy foods.

123 Operational drivers are related to the level of efficiency in the school catering services. Falasconi (2015) measured
124 the amount of food processed but not served in Italian schools resulting in over 15% of the processed food wasted.
125 Among the causes of catering inefficiency they highlighted rigid food procurement specifications, lack of attention
126 to dietary habits and menu composition. As an example, Rodriguez-Tadeo (2014) mentioned that when fruit is
127 offered without peeling and unsliced waste was comparatively higher. Different operational waste generators are

128 mentioned across the literature. For example, Bergman (2004) observed that children who had more time to eat
129 their lunches consumed significantly more food and nutrients than the others.

130 Situational factors are related to canteen environment, such as noisy or too crowded dining rooms, rushed
131 mealtimes or practical difficulties in eating such as cutting or peeling food (Comstock, 1979; School Food Trust,
132 2009; Wrap, 2011). Table 1 summarizes the abovementioned diverse categorized food waste drivers and a couple
133 of examples of each together with the cited sources.

134

135

Table 1: Food Waste drivers categorisation

Category	Driver (e.g.)	Authors
Behavioural reasons	Student attitudes towards food waste Environmental awareness	(Cooke <i>et al.</i> , 2011; Mirosa <i>et al.</i> , 2016; Williams <i>et al.</i> , 2012; Yoon & Kim, 2012)
Operational reasons	Procurement specifications Menu composition	(Falasconi <i>et al.</i> , 2015; Rodriguez Tadeo <i>et al.</i> , 2014)
Situational reasons	Unpleasant canteen environment Rushed meals	(Comstock, 1979; School Food Trust, 2009; Wrap, 2011)

136

137 Motives reported in the literature to reduce food waste include saving money, saving the planet, saving hungry
138 people and reducing guilt (Aschemann-Witzel, de Hooge, Amani, Bech-Larsen, & Oostindjer, 2015). Personal values
139 such as hedonism (pleasure), self-direction (feeling full, not hungry), and security (eat enough to sustain oneself)
140 have also been listed. Hedonism and self-direction have been considered the dominant values that influence
141 wasting food, together with tradition, as individuals who have grown up with the belief that they need to clear their
142 plates, and waste less food (Mirosa *et al.*, 2016, p. 2). As a consequence, they suggest that pre-ordering food can
143 be an effective intervention technique which supports hedonism value through providing consumers with their
144 preferred meal option accompanied by surveying consumer preferences. Other motives for reducing food waste at
145 schools are that both schools and families could save some money (Cohen *et al.*, 2013), as students who eat more
146 at school are less likely to spend on substitute products outside the canteen.

147 There is an important number of strategies that have been researched in order to reduce the amount of food waste
148 from school lunches such as appropriately scheduling lunch, portion sizes, student involvement and incentives
149 (Buzby & Guthrie, 2002; Wilkie, 2015). Moreover, with regard to plate waste, different aspects have been reported
150 to affect children's food acceptance rates, such as preparation methods, limiting availability of competitive food
151 items (Marlette *et al.*, 2005) or family style service (Zellner & Cobuzzi, 2017). Furthermore, Just (2013) found that
152 incentives have a significant influence on encouraging children to eat fruits and vegetables during lunch at school:
153 the fraction of students eating servings of fruit and vegetables increased by 80% when incentivised in their
154 research, and waste was reduced by 33%. Campbell (2010) stated that involving school children in sustainable
155 activities and decision making was recommended as it could be a strong motivating force within and across
156 communities. In fact, in the US, where the *Offer versus Serve* provision is widely used in schools - Buzby (2002)
157 found in his research around 90% of schools using it - may be successfully reducing plate waste.

158 Bradley (Bradley, 2011, p. 3) recommends involving caretakers and canteen staff in reviewing waste data, setting
159 minimisation goals and developing improved polices and menus by including waste discussions in staff meetings.

160 Engström (2004) reported that running a food waste awareness campaign - in which pupils were involved by
161 weighing plate waste, results were displayed in the dining room and teachers discussed food waste in their classes -
162 led to a 35% reduction in plate waste. In a university environment, the result obtained by Soares after an

163 educational campaign also showed how food waste can be reduced by making students aware on the topic (Soares
 164 Pinto, Machado dos Santos Pinto, Fochat Silva Melo, Santos Campos, & Marques-dos-Santos Cordovil, 2018).
 165 Moreover, awareness campaigns are suggested to be tailored to different target groups as food waste is caused
 166 by different players and at different stages of the process, and the recommended strategies should be
 167 incentivised by different stakeholders, or even by collaboration initiatives among them (Priefer, Jörissen, &
 168 Bräutigam, 2016). Engström highlighted the fact that those schools that practise a “pedagogical lunch”, where
 169 teachers engaged in teaching children how to behave in the dining room and held discussions on food and
 170 nutrition, resulted in lower plate waste (Engström & Carlsson-Kanyama, 2004).

171 Considering that public schools are highly influenced by public policies, there is an opportunity to enhance best
 172 practices in public schools through regulation that will result in reducing food waste. Mikkola (2009) states that
 173 public procurement can help shape the production and consumption towards a more sustainable economy.
 174 Currently, publicly funded schools, guided by local governments, often require their catering suppliers a minimum
 175 percentage of organic products, stimulate purchasing local produce (Km zero), among other sustainable practices
 176 (Mikkola, 2009). We list in Table 2 a few examples of food waste minimization interventions suggested by scholars
 177 in the literature, classified by its related motivation.

178

179 **Table 2: Examples of interventions to reduce food waste at schools suggested by scholars, and their related motivation**

Motivations to reduce food waste		Related Interventions	Author
Personal Values	Hedonism (pleasure)	Pre-ordering/Choice Improved quality Preparation methods Canteen ambience & dining experience Incentives (verbal or material rewards)	(Miroso <i>et al.</i> , 2016) (Marlette <i>et al.</i> , 2005) (Buzby & Guthrie, 2002) (Just & Price, 2013)
	Self-direction	Appropriate schedule Student involvement	(Just & Price, 2013) (Marlette <i>et al.</i> , 2005)
	Universalism	Awareness Campaigns Regulations	(Engström & Carlsson-Kanyama, 2004) (Yoon & Kim, 2012) (Mikkola, 2009)
	Security	Tailoring portion sizes to appetite and needs	(Buzby & Guthrie, 2002)
	Tradition	Nutrition education	(Miroso <i>et al.</i> , 2016; Yoon & Kim, 2012)
Economy	Save money	Limit competitive food	(Marlette <i>et al.</i> , 2005) (Cohen <i>et al.</i> , 2015)
	Business Efficiency	Menu composition & planning	(Falasconi <i>et al.</i> , 2015)

180

181

182 **5. Research Question & Objectives**

183 According to public statistics, 57% primary schools and 38% secondary schools offer dining facilities in Spain. There
 184 are at present 2.9 million students in 13,915 primary schools and 1.9 million students in 8,367 secondary schools in
 185 Spain. Out of these, 805,950 primary school children and 162,252 secondary school children eat daily at school in
 186 Spain (Ministerio de Educación Cultura y Deporte, 2015). These figures shed light on the relevance of food waste
 187 analysis at school canteens in two areas: first, it gives us a first broad estimation of the amount of food waste
 188 produced at school canteens which, based on the results of studies found in the literature, we estimate can be up
 189 to 15,000 tons per year in Spain. Secondly, it also sheds light on the potential impact that an educational awareness

190 campaign could have on a huge number of future consumers, in the effort towards a more responsible and
191 sustainable food consumption.

192 This leads us to the Research Question of our study: How can food waste be addressed at school canteens so that
193 schools can contribute to a more sustainable food system?

194 In order to clarify this Research Question, we first need to understand how school canteens are sourced and
195 managed, the amount of food waste generated at schools and what causes it. Once these factors are analysed, we
196 may be able to understand how this problem should be addressed. In order to answer our Research Question, we
197 put forward the following Research Objectives:

198 O1: To identify the different business models operating at present at school canteens and their influence on food
199 waste generation.

200 O2: To understand the types and nature of food being wasted as well as at where in the process waste is
201 generated.

202 O3: To shed light on the causes that lead to food waste at school canteens.

203 O4: To Identify initiatives and practices that could lead to reduce food waste at school dining facilities.
204

205 **6. Materials and Methods**

206 Due to the diverse nature of the objectives of our study, and with the goal of responding our research question, we
207 designed a mixed methods research approach in two stages, in order to reveal deep rich details that cannot be
208 achieved through either qualitative or quantitative methods alone (Silverman, 2015) and increase value and
209 understanding of the research problem (Creswell, 2015):

210 1. Semi-structured, individual interviews with managers and staff of different institutions through an
211 explorative/inductive approach as proposed by Pratt (2009), with the purpose of obtaining insights into the
212 different school catering business models and drivers of food waste.

213 2. Waste audits at school canteens with the objective of measuring real waste data and overcome the limitation
214 due to the low visibility and awareness of waste in food service institutions.
215

216 The first research stage was conducted through thorough interviews with 12 managers and members of staff from
217 9 different institutions and organisations that play some role in the cycle of school lunches, at catering companies
218 as well as at schools (see appendix A for further information). At this point, we also interviewed another 9
219 individuals to find out the opinion of canteen staff and school personnel too. When selecting the number of
220 companies to be studied, we followed Eisenhardt and Graebner's recommendation (2007), which established
221 between four and ten cases for analysis in a qualitative study of multiple cases. The strategy of quotas was followed
222 according to the school type (semi-public, public or private establishments) and catering organisation type to select
223 the samples. Schools had to meet the following criteria to qualify for selection: prepare cooked meals in-house in a
224 canteen for a minimum of 300 pupils dining at school every lunch time. We made sure that the final sample was
225 consistent with reality in the Spanish school environment. On the other hand, we chose the catering companies
226 among those suggested by the participating schools, being a requirement that they had extensive experience, and a
227 minimum revenue of € 10 million over the last 12 months and a noteworthy market share in the institutional food
228 service channel. Additionally, the representativeness of the sample, the learning opportunities each
229 school/company added to the study and the accessibility to each of these schools/companies were considered in
230 this selection. School headteachers, managers of canteens and food service organisations from the 8 institutions
231 making up the final sample were interviewed for about 60 minutes each using a semi-structured interview design.
232 Please see Appendix A for the catering companies (4) and schools (4). Owing to the complexity of the analysis, we

233 have developed a protocol for data collection during interviews, in an attempt to provide a conceptual and
234 practical guide. This procedure introduces an open-question semi-structured design with no time limit in the hope
235 of possibly capturing unexpected results to then redirect the discussion according to the answers from the
236 interviewees. We have grouped the questions under three different sections; the first regarding the management
237 system; the second including specific questions regarding each individual production stage (procurement, kitchen,
238 food service and disposal of food waste) and lastly with questions on the interviewee's interest in the application of
239 reduction measures and best practices. Comfort and privacy issues prompted us to allow the interviewees to
240 suggest where they preferred to be interviewed. The modus operandi offers the idea to both record (sound only)
241 the interviews as well as make notes on interviewee reactions while answering questions (i.e., non-verbal
242 communication). The transcript was performed with at least two review sessions. The interviews were then coded
243 applying the method proposed by Bogdan and Biklen (1997), using the qualitative MaxQDA data analysis software.
244 Our original list of codes included 7 codes (Players, Places, Food Type, Waste Drivers, Initiatives, Waste Hierarchy,
245 Key Performance Indicators - KPIs) and the paragraphs were then coded using an inductive approach (encoding in
246 vivo), some of the interviews were re-coded whenever new codes surfaced. By the end of the research there were
247 63 codes to classify data into 10 codes (the previous 7 and 3 new ones: Management, Resources and Culture).
248 After the encoding process, following suggestions from Miles and Huberman (1994), and Jurgenson (2005), each
249 interview was analysed and later all of them in a single block aiming at a detailed image of individual cases and an
250 overall conclusion for all of the cases. The first step of this part of the analysis was to build a checklist matrix to
251 coherently organise several components for every case where matrices showed, in rows, the different sources of
252 data (interviews) and, in columns, the topics or codes (both the codes from the second and the third step of the
253 coding process). The matrices allowed us to display the interviews of the codified elements, their reliability and
254 their importance according to the number of sources that corroborated them.

255 From each case, we generated a Time-Ordered Matrix that showed the several processes throughout the study
256 period. Following a code-oriented strategy, a Case-Ordered Effects Matrix was developed (based on Miles &
257 Huberman, 1994), allowing us to see how the effects play out across the different interviewees. In other words, we
258 could sort the cases and show the diverse effects for each case in the same picture. The matrix has the cases in
259 rows along with the main features of the school, their strategies and point of view on sustainability, the point of
260 view of the catering company, and some short-run effects. From this matrix, we were able to start analysing the
261 relationship between schools and food waste.

262

263 The second stage of the research consisted in a food waste audit in four of the participating schools. In order to
264 avoid potential bias due to meal preference, the audit lasted three to five consecutive weekdays per school, thus
265 comprising different menus. The audit lasted 10 school days (Table 3). The schools in the sample included a mix of
266 socio-economic statuses, different catering arrangements, medium to large size institutions, both public and
267 private. The four schools had an in-house kitchen managed by a specialised firm because this is the most common
268 procedure at Spanish schools (as mentioned by C4 in our research). The four schools had different cafeteria layouts
269 but similar lunch schedules. Meals were composed of a starter (legumes, rice, pasta or vegetables), main dish
270 (meat or fish), white bread and a dessert (fruit or yoghurt) and tap water to drink. Children could not choose their
271 menu, except for secondary graders in schools S2 & S3 (See Appendix A) where they chose from two different
272 options for each course. One of the schools had seven different canteens and four serving lines, while the three
273 other schools had one common canteen. Two of the schools had one single serving line, and children were served
274 by the staff at their tables in only one school. School staff cooperated in the audits through setting aside the waste
275 collected from the different areas and providing access to the areas where collection stations were situated. None
276 of the schools offered a la carte items such as potato chips, as this very rarely happens in Spanish schools.

277 Every day, research assistants weighed the aggregated discarded food at each step in the process, recording total
 278 kilos as well as the approximate % of the different types of food and noting the point where it had been produced
 279 (pantry, kitchen, service station or plate waste), as suggested by Engström (2004). Research assistants arrived at
 280 schools three hours before lunchtime, in order to prepare collection bins and track kitchen preparation tasks. Bins
 281 were placed in different spots, labelled in order to collect food at each stage. First of all they measured food
 282 wasted during meal preparation, making a note of its alleged cause. All “potentially avoidable” (e.g. out of date
 283 ingredients) waste was differentiated from “unavoidable” waste such as egg shells, bones, etc. and only potentially
 284 avoidable waste was weighed. Rubbish bags were placed at different points of the kitchen with specific labels in
 285 order to record waste generated at different places separately. We therefore used 6 differently labelled bins and
 286 placed them at the different collection stations: 1) “Out of date or damaged raw ingredients”; 2) Unavoidable
 287 “kitchen scraps”; 3) Potentially avoidable “kitchen scraps”; 4) “Self-service leftovers”; 5) Unavoidable “Plate waste”,
 288 and 6) Potentially avoidable plate waste. Once the audit was finished, only four of them were weighed (using a
 289 Pelouze scale in all but one school where we used Campesa K3 scales), as we did not measure unavoidable waste,
 290 in accordance with Papargyropoulou et al.’s (2014) suggestion.
 291 Once total weight was measured, research assistants visually estimated the approximate percentage of total
 292 weight per food category. Transparent garbage bags were used to ease visual estimation. Day one at each school
 293 waste from four randomly selected bags was classified and weighted separately, as training for the researchers and
 294 to validate visual estimations. Though we acknowledge the limitations of visual estimations, we decided to use this
 295 method for the sake of simplicity in the context of a naturally frantic environment such as school canteens.
 296 Table 3 shows the total number of trays included in the trial as well as the number of days the audits lasted in each
 297 school. Overall, we measured the aggregated avoidable waste weight of over 10,000 trays, and 2,991 children took
 298 part in the audit.

300 **Table 3. Trays and pupils audited**

	Participating pupils	Trial Duration (# Days)	Elementary Pupils’ trays	Secondary Pupils’ trays	Total Audited Trays
School S1	986	5*	2,815	2,113	4,928
School S2	1,316	3	1,881	2,067	3,948
School S3	465	2	534	396	930
School S4	225	1	225	0	225
TOTAL	2,991	11	5,455	4,576	10,031

302 *(secondary pupils were present 4 four days only)

303
 304 During the audit days, we interviewed 9 canteen and school staff in order to get insights from those who work
 305 closely with the day to day operations of the canteen. The interviews in this case lasted 20 minutes on average and
 306 we encoded the transcripts following the same method and codes as in the former phase of the study.
 307 Research assistants recorded the number of pupils who in fact eat lunch in the canteen every day, to then record
 308 and calculate the average weight wasted per pupil per day. These calculations are based on Wrap (2011), who
 309 considers this measure to be the most significant way to make a comparison between various schools. This number
 310 was compared with the number of diners planned, which the cooks informed us of on audit days, following a
 311 suggestion from Papargyropoulou et al. (2014).

312

313 Data collection was performed during November and December, 2014. The reliability and validity of this study are
 314 strengthened through the use of triangulation of methods and data. Nevertheless, the limitations of this research
 315 relate to three aspects: the waste audit was conducted in four medium to big sized schools in Barcelona where
 316 most of the students eat daily. In other cities or areas it may not be so common for children to eat at school and
 317 this may influence their eating patterns. Moreover, beverages in glasses were not monitored. In the end, we were
 318 only allowed to measure kitchen and pantry waste in two out of the four participating schools. While the
 319 representativeness of this study cannot be proven, the results are aligned with previous studies such as Wrap
 320 (2011).

321

322 **7. Results & Discussion**

323

324 **7.1 Quantification of food waste at pilot schools**

325 Overall food waste was estimated in our research to be between 60 and 100 grams per pupil per day, when
 326 computing both pre-consumer (cooked but not served) and post-consumer waste (served but not eaten).
 327 Consistent with the literature, the highest amount of waste found in our audit came from plate waste, which
 328 ranged from 21g to 47g per pupil per day in primary schools and from 23.7g up to 88.0g per pupil per day in
 329 secondary schools, related to pupil's food preferences (i.e. higher plate waste volumes when vegetables and
 330 legumes were offered than when pasta or rice). Although we were only allowed to measure kitchen discards in two
 331 of the schools, these were relatively low in both of them, ranging from 3.7g to 7.3g per pupil, while display (serving
 332 lines) showed very high variations from one day to another: from 8 grams up to 65 grams per pupil in one day. The
 333 disparity was especially high in the one school where there were more than two serving lines.
 334 Results are shown in Table 4, where we present separately the results obtained in Primary and Secondary schools
 335 due to their relevance.

336

337

338

Table 4. Compositional waste at school canteens (Daily Mean Values)

Primary School Avoidable Food Waste				
	School 1 (S1) (grams per pupil / day)	School 2 (S2) (grams per pupil / day)	School 3 (S3) (grams per pupil/ day)	School 4 (S4) (grams per pupil / day)
Kitchen discards	3.7	7.3	NA *	NA *
Service Leftovers	6.1	Wide range (between 8 up to 65)	NA *	NA*
Plate waste	47	32	46	38
TOTAL AVOIDABLE FW	56.8	From 36.3 to 93.3	NA *	NA *
Secondary School Avoidable Food Waste				
	S1 (grams per pupil / day)	S2 (grams per pupil /day)	S3 (grams per pupil / day)	
Kitchen discards	3.7	7.3	NA *	
Service Leftovers	6.1	Wide range (between 8 up to 65)	NA *	
Plate waste	82.5	47	88	
TOTAL AVOIDABLE FW	92.3	From 62.3 up to 119.3	NA *	

339 *NA: Not available; We were not allowed to measure kitchen waste in schools S3 & S4

340

341 Although plate waste was found to be the biggest source of waste in all the case studies in our research, and while
342 acknowledging the qualitative nature of our research, we observed a difference between those schools which
343 declared the canteen as being included in their educational curricula (S2 & S4), this meaning the school's aim to
344 educate students in eating behaviour and patterns, as a part of their holistic educational perspective and others in
345 which the canteen was considered a fringe service offered by the school, and not related to the pupils curricula.

346 We found significant influence of this fact on the level of plate waste found in the audit. In fact, out of the four
347 schools measured, only school S2 management spoke passionately about sustainability, had a food waste person-
348 in-charge ("champion") and was currently implementing initiatives to reduce waste. Plate waste at school S2 was
349 found to be significantly low compared to the other three schools.

350 Given this, we inferred from our research that a key factor explaining the difference between those schools in our
351 sample that produced a high amount of food waste and those with low food waste rates was related to their
352 headteachers' focus on sustainability. This resulted in a much more relevant factor compared to others such as the
353 catering system, school size, etc. Consistent with data from Engstrom (2004), schools that produced less waste in
354 our sample had in common the consideration of the canteen as part of the schools' pedagogical programme and
355 not just as a fringe service, together with a high awareness on the environmental and social impact of wasting food,
356 which usually led them to enhance food waste reduction initiatives.

357

358 Plate waste was therefore found to be the main source of avoidable waste. Although waste was weighted
359 individually, we did measure separately primary from secondary graders dining rooms. We found a significant
360 difference in our sample between average plate waste left by primary and secondary pupils. Consistent with data
361 from Reger (1996), secondary school students wasted more than primary school pupils. Results regarding the
362 comparison between students of different ages differ: several scholars (e.g. Dillon & Lane, 1989; Guthrie & Buzby,
363 2002; Niaki, Moore, Chen, & Weber Cullen, 2017)) found that younger students tended to waste more than elder
364 children, while others such as Reger (1996) reached the opposite result. In our research we observed a significant
365 increase in plate waste as pupils' age increased. In our study, plate waste mass for secondary school pupils'
366 trays was close to double that of primary school pupils', leading us to the conclusion that the elder the child, the
367 higher the plate waste, as mentioned by S4 & S1.3 in the qualitative part of our research. This result strongly
368 supports the relevance of awareness and educational campaigns. Average secondary pupils' waste rates were
369 much higher than primary pupils'.

370

371 Vegetables, legumes and bread had a disproportional contribution to FW, forming the largest amounts of waste
372 found in our research.

373

374 In the following sections we describe our findings on how different factors influence food waste generation and list
375 related best practices or initiatives that could help reduce food waste, as reckoned by our interviewees.

376

377 **7. 2 Factors that determine food waste at schools and Related Interventions**

378 From the results of our research, consistent with data from the Waste and Resources Action Programme (2011),
379 we classify food waste determinants into three groups: firstly, behavioural factors among which the managers'
380 standpoint towards food waste and sustainability in general stands out; second, issues related to the catering
381 business model, operational and managerial issues and, finally, other determinants such as infrastructure, resource
382 availability and the number of diners. This classification is useful because it leads us to group key recommended
383 interventions in three areas too: pedagogical content and awareness on food waste, improved operations, and

384 resource allocation and availability. In the next section we gather initiatives that were being implemented or
385 suggested by our interviewees following the above-mentioned classification of food waste drivers and interventions.
386 Despite the results obtained in our research, additional factors have been observed in the literature which were not
387 mentioned by our interviewees (e.g. Diaz-Ruiz, Costa-Font, & Gil, 2018; Miroso et al., 2016; Misiak, Butovskaya, &
388 Sorokowski, 2018)

389 **7.2.1. Addressing Behavioural Factors**

390 Consistent with the literature, we concluded from our research that the most efficient way to tackle behavioural
391 factors would be by interventions aiming to increase awareness on food waste and education on food, nutrition
392 and waste. School headteachers and institutions may have very different visions and management styles as well as
393 diverse perspectives in their role on children's education. They may also be more or less environmentally
394 conscious, have different ethic values or even be more or less cost oriented. As mentioned before, in some cases,
395 the canteen was considered as part of the pedagogical curricula of the school, while in many other cases, lunch is
396 considered as a fringe service without any educational implication: *"It is parents' responsibility to educate them!"*
397 (C7).

398 Pedagogical orientation was found in our research to be the most relevant factor in this area: the more
399 sustainability focussed school managers and teachers are, the higher the probability of implementing waste
400 reduction initiatives. Engaging students and teachers in such initiatives is therefore key for their success, something
401 that rarely happens when school headteachers do not focus on sustainability. This is particularly relevant for plate
402 waste management. Quite often, schools lack a precise and explicit policy on plate leftovers and thus, canteen
403 supervisors make decisions based on their personal criteria. We observed that in those schools where there was an
404 explicit policy on when a student could leave the dining room (as there was in schools S2 & 4), plate waste was
405 reduced.

406 With regard to commercial catering organisations, an additional key factor related to management orientation is
407 cost efficiency. As it is a profit constrained sector, most catering companies often focus on cost-reducing policies
408 and consequently, some catering corporations (mostly multinational) include kitchen waste management in their
409 operation processes. This implies little or controlled pre-consumer food waste. Nevertheless, corporations very
410 rarely track plate waste, due to the fact that they do not consider it to have impact on their profitability nor to be
411 part of their service responsibilities. In fact, a manager from a catering business company with a high focus on
412 sustainability alleged that it was very difficult to implement food waste initiatives as they are often received with
413 susceptibility by their customers: *"Very often, when we try to promote initiatives addressing food waste, customers*
414 *complain by accusing us of wanting to reduce costs"* (C1).

415 An additional relevant issue is aesthetics (the visual appearance of food), as kids tend to refuse "ugly" food. For this
416 reason, cooks tend to reject fruit and vegetables that do not look perfect: *"I always ask suppliers for "perfect*
417 *looking" fruits because children would not eat it otherwise"* (C6). This may generate food waste at the suppliers'
418 and could be reduced by awareness campaigns, teaching children about the goodness of produce regardless of
419 their shape.

420
421 Interventions aiming to minimise food waste in this area start by embedding the goal of reducing food waste and
422 improving the sustainability of the food system in the educational and pedagogical strategy. This implies improving
423 student and staff (professors, supervisors, kitchen staff) awareness on the issue.

424 Some suggested interventions related to the Pedagogical Content are listed below:

425 • Awareness campaigns, communication of audit results to all involved; creation of "Momentums" through
426 awareness communication campaigns such as "zero waste week" or "weekly No waste day", "vegetable of the
427 month", etc. supported with graphic signage in the dining room or classrooms.

- 428 • Timely auditing and assessment on food wasted. Performing waste audits and centralized tracking of waste,
429 sharing the results such as comparison among different schools, etc. Occasional display of the global amount of
430 food wasted before discarding it.
- 431 • Education on food waste issues, with the focus on its ecological footprint.
- 432 • Increase pupil's engagement, for example by allowing them to vote Friday's menu among several options.
- 433 • Food workshops such as teaching kids how to peel fruits, tasting new flavours or bringing them closer to the
434 kitchen process so that they give more value to school food.
- 435 • Friendly competitions such as the "zero waste tray contest", in which groups of students with the highest number
436 of no waste trays get small rewards and recognition.
- 437 • Estimating and disseminating the economic cost of waste. This can be calculated by estimating the equivalent
438 number of meals annually wasted and multiplying it by the average meal cost (Derqui & Fernandez, 2017).
- 439 • Engaging staff by including food waste topics in regular meetings so that they are encouraged to provide ideas to
440 minimise waste.
- 441 • Waste awareness initiatives aiming to make waste more visible and therefore increase pupils', teachers' and staff'
442 awareness on the problem. Kitchen posters and signage could be an intervention example.
443

444 7.2.2 Addressing Managerial Issues

445 Issues related to the catering business model, operational and managerial factors can best be tackled by optimized
446 operations. We found two different types of food waste in this area: first, the influence of the catering business
447 model in the generation of Food Waste and, secondly, the impact of different operational and managerial issues. In
448 the next sections, we shall analyse these two different food waste drivers separately.

449 7.2.2.1 Food Waste Driver: Catering Business Models

450 Different models for catering provision typically include contracting out to commercial catering companies, even
451 when the school has its own kitchen facilities: *"Over 60% of the school canteen services are outsourced at present in
452 Spain"* (C4). Nevertheless, school canteens are often considered by schools as a commercial tool; they typically
453 "sell" to the families having an in-site kitchen as a high end service: *"Our food is homemade"* (S4); *"We cook
454 everything on-site"* (S.3.1).

455 This said, we identified three different business models that are used to provide meals at schools: either food is
456 cooked on site at the school, or it can be brought to the school from a central facility, transported chilled or hot. In
457 situ kitchen is the most common model, probably due to the fact that the perceived quality of food is higher when
458 freshly made.

459 Apart from plate waste, the amount of waste produced, as well as *where* in the process it is mostly produced,
460 varies depending on the business model:
461

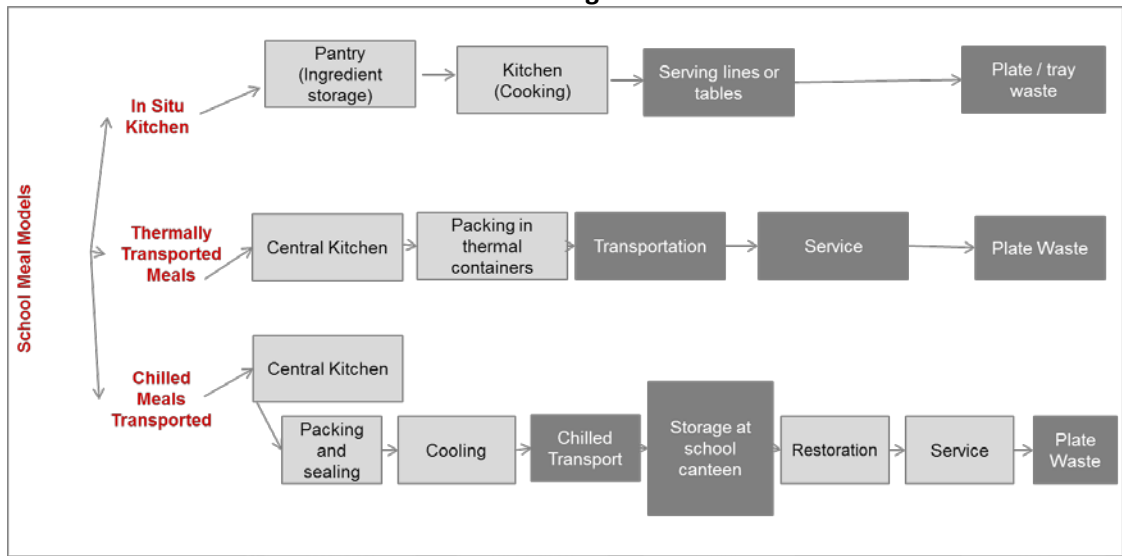
- 462 • In-situ kitchen food is prepared and served at school, for the most part under an agreement with an
463 external catering provider, as mentioned before. In this case, the school acts as the operational centre
464 because ingredients are stored, prepared, cooked and served in situ in the school's facilities. Key waste
465 drivers in this model include poor demand planning, cooking waste and scraps, plate leftovers and timed
466 out ingredients. Kitchen waste is alleged to be lower when the service is performed by a specialised
467 catering company compared to an independent service by school staff: *"We subcontracted the service
468 because we are experts in education, not in catering!; Waste has been significantly reduced since we
469 outsourced the kitchen service"* (C9).
- 470 • A second model is chilled food transport, in which schools send their orders daily to a central kitchen where
471 food is cooked, packaged in modified atmosphere containers or trays and pasteurised. Cooked meals are

then sent at low temperature to the canteens where they are regenerated. Pre-consumer food waste in this method is alleged to be low because production is centralised in a professional kitchen and meals can be regenerated at school on demand. This model is mainly used in rural areas: *“Chilled transport system reduces food waste because you can regenerate at the same pace as you need food”* (C1).

- Finally, a third catering business model is thermally transported meals. This was found in those quite exceptional cases in which a school supplies other schools off-site with catering. In this model the catering company prepares and packs the order and food is transported hot to the school canteens. This model is seldom used due to its higher sanitary risks related to more complex management (transport and handling at high temperatures) as well as higher costs. Controlling warm temperature standards is more difficult than cold temperature. The use of this model is only considered at small schools where there is very limited space and meals are provided from a nearby institution. Food waste in this case is closely related to temperature control and demand planning.

Key stages where waste is typically generated are different in each case: when food is cooked in the school kitchen, plate waste and serving lines are the main sources of waste. In both the other two cases, transport temperature control is key. As a summary, a comparison of the different processes is shown in Table 5, where critical points for the generation of food waste are highlighted. Those stages in each process where food waste was found to outstand compared to the rest are emphasized in darker grey in the figure.

Table 5. School Catering Business Models*



*Stages where waste is usually higher are highlighted in dark grey

7.2.2.2 Food Waste Driver: Operational Issues

Managerial issues affecting food waste include menu and demand planning, as well as portion management. First, with regard to procurement policies and supply chain management it is key to efficiently adapt the amount of ingredients purchased to real needs and this is only possible through good communication between kitchen and school administration staff. For instance, it is important for catering managers to get to know the exact number of diners in advance, allowing them to adjust the amount of food prepared. This is notably relevant in the case of special nutrition needs, such as gluten allergies or other intolerances. Menu planning and management is closely related to dietary guidelines and meal diversity. Actually, school menus are usually supervised or even designed by nutritionists. Governmental recommendations on child nutrition are universally accomplished in the menus offered

503 at schools, nonetheless, attending to the high proportion of vegetables, fruit and fish found in plate waste analysis
504 in our research, the accomplishment of the guidelines does not guarantee a balanced nutrition.

505 Menu diversity is not only considered related to nutritional guidelines but it also has educational implications:
506 *“We often find kids that have never tried certain types of food at home. Last month we had kiwis and a 10-year-old*
507 *girl said she had never seen one before!” (C.1.2).* Menu planning must consider a wide variety of food and different
508 types of food may have very different acceptance from pupils. Despite the importance of offering a wide variety of
509 food, it was mentioned in our research that the way of preparing food also has a relevant influence on its
510 acceptance. On the other hand, the way food is presented (e.g. peeled and sliced fruits, etc.) is also relevant, as
511 how easy it is to eat will influence plate waste too: *“The easier the food is to eat, the lower plate waste will be”*
512 *(S.2.1).* We observed one school offering pre-sliced peeled fruits to the students. In another case, workshops were
513 offered at the beginning of each school year to teach pupils how to peel and slice fruit.

514 In two out of the four schools in our sample secondary pupils could choose among different menu options, typically
515 two options for each course. This implied lower plate waste rates in one of these two schools, allegedly because
516 being able to choose their meals permits pupils to select according to their preferences at the same time as it
517 increases their implication when food waste reduction policies are implemented. Strong awareness campaigns
518 were put forth in this school.

519 Plate waste volumes were claimed by our interviewees to be closely related to the accuracy of demand forecast
520 (number of diners) as well as to kitchen staff awareness on food waste. Fluent communication between the school
521 and the kitchen was stated to be required to be able to better adjust the quantities of food to be prepared.
522 Although it is usually regulated, the size of the portions is also a factor to be considered, as for instance, the same
523 portions were served to boys and girls. Furthermore, portioning was mostly found to be done by eye and second
524 helpings were allowed in all the schools in the sample, a fact that makes it harder to adjust quantities.
525 Nevertheless, cooks alleged their predictions were usually quite accurate, based on their past experience.
526 Interestingly, they mentioned that children usually try to influence how much food they are served, depending on
527 their preferences (*“more, please!”* or *“just a little, please!”*). In big dining rooms this can result in a big difference,
528 making it hard to anticipate the real amount of food to be served *“If serving staff “give”, for example, two baby*
529 *carrots fewer to each pupil, it would mean 3,000 fewer baby carrots just in one meal! (S.1).*

530 Finally, we found that bread and side dishes were responsible for the greater part of total food waste. Most
531 significantly bread, as often pupils take it but do not eat it: *“Bread is usually located at the beginning of the line, thus*
532 *quite often pupils take it before knowing the menu” (S.2.1).*

533 Waste minimisation initiatives related to operational issues include aspects such as demand planning and
534 procurement, diversity and meal acceptance by students or optimised portion sizes. The following best practices
535 were suggested with regard to managerial aspects:

- 536 • Menu planning having waste minimisation in mind, including practices such as planning the menu of the
537 day based on the previous day’s ingredient surpluses.
- 538 • Menu planning can also be optimised by interventions such as offering pupils meal options to choose from,
539 limiting second servings to those who have finished eating all previously served food, and limiting bread.
- 540 • Being creative, giving funny or attractive names to “difficult” dishes and presenting them also in a creative
541 or more appealing way was also mentioned as an effective intervention.
- 542 • Improved communication among catering providers, school staff and students. Using up to date booking
543 systems to provide school kitchens with accurate information on total number of pupils eating school
544 dinners each day (accurate prediction was considered challenging by cooks). Better communication will
545 help in predicting the amount of each meal option that will be required.

546 Special attention was drawn to demand planning and consequently to adjusting procurement. This can be
547 optimised through interventions such as using efficient demand planning software and daily supervisions,
548 among others.

549 7.2.3. Minimising Situational Drivers

550 Other diverse factors to be considered for their influence on the amount of food waste produced at schools may
551 be related to the availability of certain resources such as school kitchen facilities, human resources or other
552 situational drivers such as time constraints, family socioeconomic level or even the size of the school. An additional
553 driver for food waste is related to regulations and contract liabilities. These factors can be addressed by resource
554 allocation and regulation. Due to the diverse nature of such drivers, we analyse them separately in the next
555 sections.

556 7.2.3.1 Food Waste Driver: Resource Availability

557 School food waste is influenced by the diverse resources of catering companies and institutions, either physical
558 (facilities) or human (teachers, supervisors, cooks). Some of these resources are structural, such as the size of and
559 equipment in the kitchen or the dining room, while human factors, such as staff implication and availability are
560 more closely related to the headteacher's vision.

561 Noise levels, queues or even lighting in the dining room are determinants too. The more relaxed the ambience, the
562 lower plate waste will be. Kitchenware was also mentioned as an influencer.

563 We also found that the smaller the school canteen, the easier it resulted in adjusting menus and adapting them to
564 child preferences. On the other hand, at big schools, time for lunch is usually shorter as there are often several
565 shifts, and a bigger catering staff: *"In big institutions, it is often necessary to work with a lot of staff, thus it becomes
566 more difficult to properly communicate instructions from headquarters"* (C.1.3).

567 Moreover, time constraints can also become a waste generator, especially whenever there is more than one shift in
568 the same dining room; some kids are usually "pushed" to leave: *"The longer the time available for lunch, the lower
569 the plate waste"* (S.3.1). Another relevant factor is the previous scheduled recess time. As many kids eat a sandwich
570 (brought from home) at mid-morning recess in Spain, whenever recess time is close to lunchtime, plate waste was
571 found to be higher as pupils may not be so hungry.

572 Human Resources were found to be the most critical factor influencing food waste. The supervisor's role is key and
573 has a direct influence on plate waste rates. Low plate waste is highly related to control by supervisors and teachers,
574 not letting pupils leave the dining room before emptying their plates. This practice was observed in our case study
575 in schools S2 & S4. Moreover, caretakers often lack clear instructions or training. This said, we found that the
576 number of pupils per supervisor was a crucial factor too: *"25 pupils per supervisor is fine"* (S.1.3). Staff attitude can
577 also make a difference: *"The dining experience can be enhanced by friendly staff"* (C.1.3).

578 Optimal physical and human resource allocation would be related to the creation of the appropriate dining room
579 ambience as well as to the team of supervisors who should be specialised and well dimensioned. The following best
580 practices were suggested in this area:

- 581 • Hiring a meal supervisor team with this specific function.
- 582 • Training programmes for supervisors.
- 583 • Use of physical systems to minimise noise such as ceiling panels, etc.
- 584 • Dining room decoration so that it creates a more relaxed and "Home like" ambience
- 585 • Creating a green garden at school and composting facilities on site.

586 This said, we also found that plate waste rates may significantly differ among different geographic areas basically
587 due to the diverse socioeconomic level of the families. One of our interviewees, a manager in a catering company
588 that operates nationwide stated: *"We find little plate waste in depressed areas; in some cases, school lunch might
589 be the only warm meal they have during the day"* (C.2.1).

590 7.2.3.2 Food Waste Driver: Regulations and legal obligations.

591 Contract liabilities may also influence food waste as caterers may be obliged by contract to provide different
592 options until the end of the service. Health and safety regulations, determine food waste generation too as, for
593 instance, they limit the possibilities of re-using unserved food. Most importantly, surplus food donations are
594 regulated in most countries and this is usually a disincentive for donors due to legal liabilities once food is donated.
595 Interestingly, in countries such as the US and Italy, this is solved by a so called “Good Samaritan Food Donation
596 Act”, which frees donors from liabilities when donating to non-profit organisations.

597 Coordination meetings and shared procedures would be necessary to reduce food waste originated by these
598 former drivers. Collaboration among the different stakeholders becomes at this point the key to successful
599 initiatives.

600

601 **8. Conclusion**

602 School cafeterias offer a unique opportunity to increase current and future sustainability of the food system.
603 Regardless of the business model, plate waste is a high source of food waste at schools. It is mostly avoidable and
604 very strongly influenced by the school’s educational perspectives. School headteachers, canteen supervisors and
605 teachers play a relevant role in facilitating, designing and implementing waste minimisation interventions. The
606 human factor has arisen as the most relevant one when aiming to minimise food waste.

607 Some of the potential interventions suggested by our interviewed to be applied in school canteens in order to
608 reduce food waste are related to lunch supervision by caretakers, education and increased awareness by both
609 pupils and staff, as well as improved operations, planning and communication.

610 Interventions at schools have a double-fold benefit: first, school canteens have been proved as a very relevant
611 source of food waste, shedding light on the potential benefit of implementing minimisation initiatives; secondly, by
612 increasing awareness and education on food waste in the school environment we are also influencing future
613 consumer habits concerning sustainability and therefore improving the sustainability of the food system in the
614 future.

615 Our study makes relevant contributions to the literature on food waste. First, we categorise school canteen food
616 waste drivers and list related interventions. Second, we shed light on the key stages where waste is produced
617 differentiating according to the catering business model.

618 Our study is correlational in nature. Due to the fact that only four school canteens in Barcelona took part of our
619 research, and despite the number of participating pupils (2,991) and audited trays (10,031) was considerable, our
620 results could be biased by sociological characteristics (like wealth or education) of families that send their children
621 to these particular schools or even geographical characteristics as all the participating schools were based in
622 Barcelona. Researchers have found relevant cultural differences in moral judgements on foodwasting MISIAK 2018,

623 Further research is recommended among a wider sample of schools, in order to understand whether there are
624 significant differences among diverse schools. The feasibility in the application of waste minimization interventions
625 as well as the level of attractiveness of the suggested initiatives should also be object of study.
626

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632

633 **APPENDIX A. Sample characteristics**

INSTITUTION	Type of organisation	Number of employees/pupils	Profile & Number of people interviewed
C1	Food service	18,000 Million € Global Revenue 420,000 employees Operates in 80 countries Headquarters in FR	C.1.1 Marketing Manager C.1.2 Opex Manager C.1.3 Social Responsibility Manager
C2	Food service	Headquarters in Spain, operates regionally (Barcelona only)	C.2.1 Sales Managers C.2.2 Purchasing Manager
C3	Food service	Headquarters in the UK. 17,000 million pounds in 50 countries (group)	C.3 Regional Sales Manager
C4	Food service	14,329 billion USD revenue 270,000 employees in 21 countries. Headquarters in the US	C.4 Regional Sales Manager
S1	Elementary & Secondary School	1,500 pupils eat daily 2 dining rooms and two service lines	S.1.1 Canteen manager S.1.2 Cook S.1.3a & b: 2 kitchen assistants S.1.4 a, b & c: 3 caretakers
S2	Private Elementary & Secondary School	1,500 pupils eat daily Seven dining rooms and 4 service lines Compost facilities	S.2.1 Canteen manager S.2.2a & 2b supervisors S.2.3 a to d: 4 pupils
S3	Private Elementary & Secondary School	670 daily diners	S.3.1 Canteen coordinator S.3.2 Cook
S4	Public Elementary School	250 daily diners Pupils are served at their table	S.4 Canteen coordinator

634

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