Aquesta és una còpia de la versió *author’s final draft* d’un article publicat a la revista *Appetite*.

URL d’aquest document a UPCommons E-prints:

[https://upcommons.upc.edu/handle/2117/122082](https://upcommons.upc.edu/handle/2117/122082)

**Article publicat / Published paper:**


© 2018. Aquesta versió està disponible sota la llicència CC-BY-NCND 3.0 [http://creativecommons.org/licenses/by-nc-nd/3.0/es/](http://creativecommons.org/licenses/by-nc-nd/3.0/es/)
Towards more Sustainable Food Systems

Addressing Food waste at school canteens

Belén Derqui, Vicenc Fernandez, Teresa Fayos

1. Introduction

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

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

The goal of this research is to describe drivers that contribute to food waste at schools as well as to identify strategies that could lead to its reduction. To do this we conducted an explorative mixed method research approach: we started with 12 in-depth interviews among managers and staff of different institutions that play a role in school meals; then we directly measured waste from over 10,000 trays in four schools in Barcelona. At the end of this study we now hold useful information regarding the feasibility of implementing different interventions in order to improve the sustainability of school food systems. This will be useful for school managers as well as for food service and catering corporations in their process of planning their corporate sustainability strategies and even their marketing plans.
2. School Food Environment

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

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

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

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

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

This said, the amount of food wasted at schools has been the object of numerous studies, which have shed light on the relevance of addressing this topic at school canteens. Striking results have been obtained by researchers such as Byker (2014), who computed that 45.3% of total food served to students in a school in the US was wasted; or Bergman (2004), whose study showed that between 18.9% and 28.5% of calories offered were finally wasted. Whatley (1996) had also concluded that children consumed approximately 25% less energy than served. Other researchers have estimated waste by food type (e.g. Byker et al., 2014; Marlette, Templeton, & Panemangalore, 2005; Smith & Cunningham-Sabo, 2014), reaching similar results: over 40% fruit and over 30% vegetables served were finally wasted by students during the period studied by the cited authors.
surprisingly, despite these striking figures, a survey among cafeteria managers in the US in 1996 showed that 55% of them perceived food waste as “little or no problem” (US General Accounting Office, 1996), possibly as a result of the low visibility of food waste in food service institutions (Derqui et al., 2016). Interestingly, cafeteria managers within this US 1996 study were more likely to report that plate waste was at least a moderate problem than did school managers, probably due to being closer to where waste is produced.

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

4. Food Waste drivers at school canteens and recommended interventions

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

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

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

Operational drivers are related to the level of efficiency in the school catering services. Falasconi (2015) measured the amount of food processed but not served in Italian schools resulting in over 15% of the processed food wasted. Among the causes of catering inefficiency they highlighted rigid food procurement specifications, lack of attention to dietary habits and menu composition. As an example, Rodriguez-Tadeo (2014) mentioned that when fruit is offered without peeling and unsliced waste was comparatively higher. Different operational waste generators are
mentioned across the literature. For example, Bergman (2004) observed that children who had more time to eat their lunches consumed significantly more food and nutrients than the others.

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

Table 1: Food Waste drivers categorisation

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

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

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

Bradley (Bradley, 2011, p. 3) recommends involving caretakers and canteen staff in reviewing waste data, setting minimisation goals and developing improved polices and menus by including waste discussions in staff meetings. Engström (2004) reported that running a food waste awareness campaign - in which pupils were involved by weighing plate waste, results were displayed in the dining room and teachers discussed food waste in their classes - led to a 35% reduction in plate waste. In a university environment, the result obtained by Soares after an
educational campaign also showed how food waste can be reduced by making students aware on the topic (Soares Pinto, Machado dos Santos Pinto, Fochat Silva Melo, Santos Campos, & Marques-dos-Santos Cordovil, 2018). Moreover, awareness campaigns are suggested to be tailored to different target groups as food waste is caused by different players and at different stages of the process, and the recommended strategies should be incentivised by different stakeholders, or even by collaboration initiatives among them (Priefer, Jörissen, & Bräutigam, 2016). Engström highlighted the fact that those schools that practise a “pedagogical lunch”, where teachers engaged in teaching children how to behave in the dining room and held discussions on food and nutrition, resulted in lower plate waste (Engström & Carlsson-Kanyama, 2004).

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

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

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

5. Research Question & Objectives

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

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

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

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

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

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

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

6. Materials and Methods

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

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

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

The first research stage was conducted through thorough interviews with 12 managers and members of staff from 9 different institutions and organisations that play some role in the cycle of school lunches, at catering companies as well as at schools (see appendix A for further information). At this point, we also interviewed another 9 individuals to find out the opinion of canteen staff and school personnel too. When selecting the number of companies to be studied, we followed Eisenhardt and Graebner’s recommendation (2007), which established between four and ten cases for analysis in a qualitative study of multiple cases. The strategy of quotas was followed according to the school type (semi-public, public or private establishments) and catering organisation type to select the samples. Schools had to meet the following criteria to qualify for selection: prepare cooked meals in-house in a canteen for a minimum of 300 pupils dining at school every lunch time. We made sure that the final sample was consistent with reality in the Spanish school environment. On the other hand, we chose the catering companies among those suggested by the participating schools, being a requirement that they had extensive experience, and a minimum revenue of € 10 million over the last 12 months and a noteworthy market share in the institutional food service channel. Additionally, the representativeness of the sample, the learning opportunities each school/company added to the study and the accessibility to each of these schools/companies were considered in this selection. School headteachers, managers of canteens and food service organisations from the 8 institutions making up the final sample were interviewed for about 60 minutes each using a semi-structured interview design. Please see Appendix A for the catering companies (4) and schools (4). Owing to the complexity of the analysis, we
have developed a protocol for data collection during interviews, in an attempt to provide a conceptual and practical guide. This procedure introduces an open-question semi-structured design with no time limit in the hope of possibly capturing unexpected results to then redirect the discussion according to the answers from the interviewees. We have grouped the questions under three different sections; the first regarding the management system; the second including specific questions regarding each individual production stage (procurement, kitchen, food service and disposal of food waste) and lastly with questions on the interviewee’s interest in the application of reduction measures and best practices. Comfort and privacy issues prompted us to allow the interviewees to suggest where they preferred to be interviewed. The modus operandi offers the idea to both record (sound only) the interviews as well as make notes on interviewee reactions while answering questions (i.e., non-verbal communication). The transcript was performed with at least two review sessions. The interviews were then coded applying the method proposed by Bogdan and Biklen (1997), using the qualitative MaxQDA data analysis software. Our original list of codes included 7 codes (Players, Places, Food Type, Waste Drivers, Initiatives, Waste Hierarchy, Key Performance Indicators - KPIs) and the paragraphs were then coded using an inductive approach (encoding in vivo), some of the interviews were re-coded whenever new codes surfaced. By the end of the research there were 63 codes to classify data into 10 codes (the previous 7 and 3 new ones: Management, Resources and Culture). After the encoding process, following suggestions from Miles and Huberman (1994), and Jurgenson (2005), each interview was analysed and later all of them in a single block aiming at a detailed image of individual cases and an overall conclusion for all of the cases. The first step of this part of the analysis was to build a checklist matrix to coherently organise several components for every case where matrices showed, in rows, the different sources of data (interviews) and, in columns, the topics or codes (both the codes from the second and the third step of the coding process). The matrices allowed us to display the interviews of the codified elements, their reliability and their importance according to the number of sources that corroborated them.

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

The second stage of the research consisted in a food waste audit in four of the participating schools. In order to avoid potential bias due to meal preference, the audit lasted three to five consecutive weekdays per school, thus comprising different menus. The audit lasted 10 school days (Table 3). The schools in the sample included a mix of socio-economic statuses, different catering arrangements, medium to large size institutions, both public and private. The four schools had an in-house kitchen managed by a specialised firm because this is the most common procedure at Spanish schools (as mentioned by C4 in our research). The four schools had different cafeteria layouts but similar lunch schedules. Meals were composed of a starter (legumes, rice, pasta or vegetables), main dish (meat or fish), white bread and a dessert (fruit or yoghurt) and tap water to drink. Children could not choose their menu, except for secondary graders in schools S2 & S3 (See Appendix A) where they chose from two different options for each course. One of the schools had seven different canteens and four serving lines, while the three other schools had one common canteen. Two of the schools had one single serving line, and children were served by the staff at their tables in only one school. School staff cooperated in the audits through setting aside the waste collected from the different areas and providing access to the areas where collection stations were situated. None of the schools offered a la carte items such as potato chips, as this very rarely happens in Spanish schools.
Every day, research assistants weighed the aggregated discarded food at each step in the process, recording total kilos as well as the approximate % of the different types of food and noting the point where it had been produced (pantry, kitchen, service station or plate waste), as suggested by Engström (2004). Research assistants arrived at schools three hours before lunchtime, in order to prepare collection bins and track kitchen preparation tasks. Bins were placed in different spots, labelled in order to collect food at each stage. First of all they measured food wasted during meal preparation, making a note of its alleged cause. All “potentially avoidable” (e.g. out of date ingredients) waste was differentiated from “unavoidable” waste such as egg shells, bones, etc. and only potentially avoidable waste was weighed. Rubbish bags were placed at different points of the kitchen with specific labels in order to record waste generated at different places separately. We therefore used 6 differently labelled bins and placed them at the different collection stations: 1) “Out of date or damaged raw ingredients”; 2) Unavoidable “kitchen scraps”; 3) Potentially avoidable “kitchen scraps”; 4) “Self-service leftovers”; 5) Unavoidable “Plate waste”, and 6) Potentially avoidable plate waste. Once the audit was finished, only four of them were weighed (using a Pelouze scale in all but one school where we used Campesa K3 scales), as we did not measure unavoidable waste, in accordance with Papargyropoulou et al.’s (2014) suggestion.

Once total weight was measured, research assistants visually estimated the approximate percentage of total weight per food category. Transparent garbage bags were used to ease visual estimation. Day one at each school waste from four randomly selected bags was classified and weighted separately, as training for the researchers and to validate visual estimations. Though we acknowledge the limitations of visual estimations, we decided to use this method for the sake of simplicity in the context of a naturally frantic environment such as school canteens. Table 3 shows the total number of trays included in the trial as well as the number of days the audits lasted in each school. Overall, we measured the aggregated avoidable waste weight of over 10,000 trays, and 2,991 children took part in the audit.

<table>
<thead>
<tr>
<th>Participating pupils</th>
<th>Trial Duration (# Days)</th>
<th>Elementary Pupils’ trays</th>
<th>Secondary Pupils’ trays</th>
<th>Total Audited Trays</th>
</tr>
</thead>
<tbody>
<tr>
<td>School S1</td>
<td>986</td>
<td>5*</td>
<td>2,815</td>
<td>4,928</td>
</tr>
<tr>
<td>School S2</td>
<td>1,316</td>
<td>3</td>
<td>1,881</td>
<td>3,948</td>
</tr>
<tr>
<td>School S3</td>
<td>465</td>
<td>2</td>
<td>534</td>
<td>930</td>
</tr>
<tr>
<td>School S4</td>
<td>225</td>
<td>1</td>
<td>225</td>
<td>0</td>
</tr>
<tr>
<td>TOTAL</td>
<td>2,991</td>
<td>11</td>
<td>5,455</td>
<td>10,031</td>
</tr>
</tbody>
</table>

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

During the audit days, we interviewed 9 canteen and school staff in order to get insights from those who work closely with the day to day operations of the canteen. The interviews in this case lasted 20 minutes on average and we encoded the transcripts following the same method and codes as in the former phase of the study.

Research assistants recorded the number of pupils who in fact eat lunch in the canteen every day, to then record and calculate the average weight wasted per pupil per day. These calculations are based on Wrap (2011), who considers this measure to be the most significant way to make a comparison between various schools. This number was compared with the number of diners planned, which the cooks informed us of on audit days, following a suggestion from Papargyropoulou et al. (2014).
Data collection was performed during November and December, 2014. The reliability and validity of this study are strengthened through the use of triangulation of methods and data. Nevertheless, the limitations of this research relate to three aspects: the waste audit was conducted in four medium to big sized schools in Barcelona where most of the students eat daily. In other cities or areas it may not be so common for children to eat at school and this may influence their eating patterns. Moreover, beverages in glasses were not monitored. In the end, we were only allowed to measure kitchen and pantry waste in two out of the four participating schools. While the representativeness of this study cannot be proven, the results are aligned with previous studies such as Wrap (2011).

7. Results & Discussion

7.1 Quantification of food waste at pilot schools

Overall food waste was estimated in our research to be between 60 and 100 grams per pupil per day, when computing both pre-consumer (cooked but not served) and post-consumer waste (served but not eaten). Consistent with the literature, the highest amount of waste found in our audit came from plate waste, which 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 secondary schools, related to pupil’s food preferences (i.e. higher plate waste volumes when vegetables and legumes were offered than when pasta or rice). Although we were only allowed to measure kitchen discards in two of the schools, these were relatively low in both of them, ranging from 3.7g to 7.3g per pupil, while display (serving lines) showed very high variations from one day to another: from 8 grams up to 65 grams per pupil in one day. The disparity was especially high in the one school where there were more than two serving lines.

Results are shown in Table 4, where we present separately the results obtained in Primary and Secondary schools due to their relevance.

<table>
<thead>
<tr>
<th>Table 4. Compositional waste at school canteens (Daily Mean Values)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Primary School Avoidable Food Waste</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>School 1 (S1)</strong></td>
</tr>
<tr>
<td>Kitchen discards</td>
</tr>
<tr>
<td>Service Leftovers</td>
</tr>
<tr>
<td>Plate waste</td>
</tr>
<tr>
<td>TOTAL AVOIDABLE FW</td>
</tr>
<tr>
<td><strong>Secondary School Avoidable Food Waste</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>S1</strong></td>
</tr>
<tr>
<td>Kitchen discards</td>
</tr>
<tr>
<td>Service Leftovers</td>
</tr>
<tr>
<td>Plate waste</td>
</tr>
<tr>
<td>TOTAL AVOIDABLE FW</td>
</tr>
</tbody>
</table>
Although plate waste was found to be the biggest source of waste in all the case studies in our research, and while acknowledging the qualitative nature of our research, we observed a difference between those schools which declared the canteen as being included in their educational curricula (S2 & S4), this meaning the school’s aim to educate students in eating behaviour and patterns, as a part of their holistic educational perspective and others in which the canteen was considered a fringe service offered by the school, and not related to the pupils curricula.

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

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

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

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

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

### 7.2 Factors that determine food waste at schools and Related Interventions

From the results of our research, consistent with data from the Waste and Resources Action Programme (2011), we classify food waste determinants into three groups: firstly, behavioural factors among which the managers’ standpoint towards food waste and sustainability in general stands out; second, issues related to the catering business model, operational and managerial issues and, finally, other determinants such as infrastructure, resource availability and the number of diners. This classification is useful because it leads us to group key recommended interventions in three areas too: pedagogical content and awareness on food waste, improved operations, and
resource allocation and availability. In the next section we gather initiatives that were being implemented or suggested by our interviewees following the above-mentioned classification of food waste drivers and interventions. Despite the results obtained in our research, additional factors have been observed in the literature which were not mentioned by our interviewees (e.g. Diaz-Ruiz, Costa-Font, & Gil, 2018; Mirosa et al., 2016; Misiak, Butovskaya, & Sorokowski, 2018).

7.2.1. Addressing Behavioural Factors

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

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

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

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

Interventions aiming to minimise food waste in this area start by embedding the goal of reducing food waste and improving the sustainability of the food system in the educational and pedagogical strategy. This implies improving student and staff (professors, supervisors, kitchen staff) awareness on the issue. Some suggested interventions related to the Pedagogical Content are listed below:

- Awareness campaigns, communication of audit results to all involved; creation of “Momentums” through awareness communication campaigns such as “zero waste week” or “weekly No waste day”, “vegetable of the month”, etc. supported with graphic signage in the dining room or classrooms.
• Timely auditing and assessment on food wasted. Performing waste audits and centralized tracking of waste, sharing the results such as comparison among different schools, etc. Occasional display of the global amount of food wasted before discarding it.

• Education on food waste issues, with the focus on its ecological footprint.

• Increase pupil’s engagement, for example by allowing them to vote Friday’s menu among several options.

• Food workshops such as teaching kids how to peel fruits, tasting new flavours or bringing them closer to the kitchen process so that they give more value to school food.

• Friendly competitions such as the “zero waste tray contest”, in which groups of students with the highest number of no waste trays get small rewards and recognition.

• Estimating and disseminating the economic cost of waste. This can be calculated by estimating the equivalent number of meals annually wasted and multiplying it by the average meal cost (Derqui & Fernandez, 2017).

• Engaging staff by including food waste topics in regular meetings so that they are encouraged to provide ideas to minimise waste.

• Waste awareness initiatives aiming to make waste more visible and therefore increase pupils’, teachers’ and staff’ awareness on the problem. Kitchen posters and signage could be an intervention example.

7.2.2 Addressing Managerial Issues

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

7.2.2.1 Food Waste Driver: Catering Business Models

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

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

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

• In-situ kitchen food is prepared and served at school, for the most part under an agreement with an external catering provider, as mentioned before. In this case, the school acts as the operational centre because ingredients are stored, prepared, cooked and served in situ in the school’s facilities. Key waste drivers in this model include poor demand planning, cooking waste and scraps, plate leftovers and timed out ingredients. Kitchen waste is alleged to be lower when the service is performed by a specialised catering company compared to an independent service by school staff: “We subcontracted the service because we are experts in education, not in catering!; Waste has been significantly reduced since we outsourced the kitchen service” (C9).

• A second model is chilled food transport, in which schools send their orders daily to a central kitchen where 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
at schools, nonetheless, attending to the high proportion of vegetables, fruit and fish found in plate waste analysis in our research, the accomplishment of the guidelines does not guarantee a balanced nutrition.

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

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

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

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

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

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

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

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

7.2.3.1 Food Waste Driver: Resource Availability

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

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

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

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

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

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

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

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

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

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

8. Conclusion

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

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

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

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

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

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

9. Acknowledgements

This research was partly funded by the Spanish Ministry of Food and Agriculture. The authors want to thank the Ministry for their initiative “More Food, Less Waste”, under which framework this research was done. We are extremely thankful to Antonio Agustín, founder and CEO of El Indice K for his support and helpful ideas. Finally, we thank all organisations and contact people for sharing information.

APPENDIX A. Sample characteristics
<table>
<thead>
<tr>
<th>INSTITUTION</th>
<th>Type of organisation</th>
<th>Number of employees/pupils</th>
<th>Profile &amp; Number of people interviewed</th>
</tr>
</thead>
</table>
| 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 |

**Bibliography**


https://doi.org/10.1016/j.foodqual.2016.08.007