UNIVERSITAT POLITÈCNICA DE CATALUNYA BARCELONATECH

Towards more sustainable food systems

Belén Derqui Zaragoza

Towards More Sustainable Food Systems

Ph.D. Thesis

By

BELÉN DERQUI ZARAGOZA

Ph.D. Advisor

Dr. VICENÇ FERNÁNDEZ

Department of Management

UNIVERSITAT POLITÈCNICA DE CATALUNYA – BARCELONA TECH

PhD Thesis *submitted* to the Universitat Politècnica de Catalunya – BarcelonaTech in accordance with the requirements of the PhD. program in BUSINESS ADMINISTRATION AND MANAGEMENT in the Department of Management.

ACADEMIC YEAR: 2016-2017

Acta de calificación de tesis doctoral Curso Académico 2016/17

Nombre y apellidos
BELÉN DERQUI ZARAGOZA

Programa de doctorado
Administración y Dirección de Empresas

Unidad estructural responsable del programa
Departamento de Organización de Empresas

Resolución del Tribunal

Reunido el Tribunal designado a tal efecto, el doctorando / la doctoranda expone el tema de su tesis doctoral titulada: **TOWARDS MORE SUSTAINABLE FOOD SYSTEMS**.
Acabada la lectura y después de dar respuesta a las cuestiones formuladas por los miembros titulares del tribunal, éste otorga la calificación de:

☐ NO APTO ☐ APROBADO ☐ NOTABLE ☐ SOBRESALIENTE

Nombre, apellidos y firma	Nombre, apellidos y firma	Nombre, apellidos y firma
Presidente/a	Secretario/a	Vocal

Barcelona, a xxx de xxxx de 2017

El resultado del escrutinio de los votos emitidos por los miembros titulares del tribunal, efectuado por la Escuela de Doctorado, a instancia de la Comisión de Doctorado de la UPC, otorga la MENCIÓN CUM LAUDE:

☐ SÍ ☐ NO

Nombre, apellidos y firma	Nombre, apellidos y firma
Presidente de la Comisión Permanente	Secretario de la Comisión Permanente de

Barcelona, a xxx de xxxx de 2017

ABSTRACT

Context: Globalization, increased competition for natural resources, the rise of non-financial performance indicators in decision making, among other new trends have made sustainability more and more relevant and linked to business performance. Food corporations face a particularly challenging environment, and therefore understanding in which ways can business managers improve the sustainability of the global food supply chain becomes decisive. As a result of unsustainable production and consumption, food waste has emerged as a global issue with relevant implications in the three spheres of sustainability.

Objectives: The goal of this Doctoral Thesis is to find out opportunities and paths for business managers related to sustainability. As a secondary objective, we aimed to understand business practices that could lead to food waste minimization. To achieve these goals, we have divided the research in three studies. The first one aimed to understand the relevance of food waste in the food service sector in Spain, categorize what is considered food waste and describe its drivers as well as reduction best practices. Through the second study we developed an auditing tool to help measuring food waste in educational institutions and, finally, in the third study we list and prioritize food waste reduction interventions based on school managers´ willingness to adopt them.

Method: The studies performed in this thesis follow deductive as well as inductive processes. We obtained and analysed both qualitative and quantitative data from different sources, essentially food service corporations, with a focus on school catering, as well as their main stakeholders. The field of the research was Spain. We used a mixed methods approach, including in-depth interviews to food service organizations and school managers, a waste audit in which we measured food waste from over 10,000 meals in four schools in Barcelona and a questionnaire with 420 responses by school principals.

Results: : The role of top management in the sustainability of an organization is key, and there is an important lack of visibility and awareness on how much food is wasted. We identified best practices that could improve the sustainability of the food supply chain and developed a self- assessment tool to be used by schools in order to measure and track food waste at their canteens. We came up with three different categorizations of food waste and concluded on reduction best practices using these classifications. In brief, we found two main areas of action to address food waste: 1) Improving the visibility and awareness of waste in order to tackle pre-consumer waste because managers will translate this into an opportunity of improved efficiency; and, 2) Reducing post-consumer waste (mainly plate waste) through educational and awareness campaigns.

Implications: The result of this research will allow business managers a better understanding of unsustainable practice drivers and hence will help food corporations and schools to move towards sustainability. Moreover, I aim to shed light on new business practices required for food corporations in order to embrace sustainability and therefore long term success.

ACKNOWLEDGEMENTS

I want to express my sincere gratitude to my thesis director, Dr. Vicenç Fernandez, who has supported and accompanied me throughout the process. He introduced me to the world of scientific research, which was novel for me. Moreover, he taught me from the most basic concepts to the more complex ones, with a rigorous and at the same time flexible methodology. Without his devotion, this thesis would not have been possible.

I also need to thank Mr Antonio Agustín, CEO of the consulting firm El Índice K for introducing me to the fascinating world of business sustainability and to the Spanish Ministry of Food and Agriculture for their initiative "More Food, Less Waste", under which framework this research begun.

Above all I need to thank my three sons for the hugs and the laughs and for being my everything.

Lastly, I want to dedicate this work to the memory of my father, who would have been really proud of it and from whom I learnt the value of effort and hard work. I also want to express my gratitude to my mother who would have deeply enjoyed (and celebrated) my dissertation defence, in the hope that she fully recovers soon.

PERSONAL IMPLICATIONS

From the privileged perspective of having worked in a multinational business environment for over 20 years, complemented with my recent experience in the academic world, it is my purpose to continue doing research on different ways to incentivize and facilitate businesses towards more sustainable practices.

AUTHOR'S DECLARATION

I declare that the work in this Ph.D. thesis was carried out in accordance with the regulations of the Universitat Politècnica de Catalunya - BarcelonaTech and the requirements of the Ph.D. program in Business Administration and Management in the Department of Management. Except where indicated by specific reference in the text, the work is the candidate's own work. Work done in collaboration with, or with the assistance of, others, is indicated as such. Any views expressed in the dissertation are those of the author.

SIGNED: ……. DATE: …….

TABLE OF CONTENTS

LIST OF TABLES

TABLE **PAGE**

CHAPTER 1

INTRODUCTION

Globalization, increased competition for natural resources, the rise of non-financial performance indicators in decision making, among other new trends have made sustainability more and more relevant and linked to business performance. Food corporations face a particularly challenging environment and therefore, understanding in which ways can business managers improve the sustainability of the global food system becomes decisive.

Climate change is real, resources are more and more scarce. We are consuming natural resources at a quicker pace than our planet produces them while predictions for population increase for the next decades, together with average wealth growth puts a higher pressure on the Earths´ bio capacity. The consequences are massive: greenhouse gas emissions growing exponentially; thousands of species under risk of extinction; deforestation increasing at alarming rates; pollution killing over a million people every year, and a well-known long etcetera. World production of food will need to increase by 70% to be able to satisfy food demand in the next decades (FAO, 2009), at the same time that there is less available soil - in 1950 there were 5,600 square metres of cultivable soil per capita; in 2050, experts estimate 1,500 - and fisheries are already too exploited (Godfray, Beddington, et al., 2010).

We face a new era. The horn of plenty is worn out. Over-consumption is past. Sustainable development, defined by the World Commission on Environment and Development as '*meeting the needs of the present without compromising the ability of future generations to meet their own needs*' (Brundtland, 1987, p. 16) seems somehow impossible to attain. Under this context, the food system is closely related to sustainability as one of the main challenges that we face is food security. Being able to feed a growing global population with more and more scarce resources is the equation to be solved in the next decades.

Some authors are really negative about the future. Others distrust. Myself, I truly believe we must all become part of the solution, as we are all part of the problem. There are reasons to be optimistic, this is not the first time we face global challenges. We must sum up efforts, as we did some years ago when the ozone hole was a threat and different countries and people reached an agreement to inverse the trend. I believe in humans` capacity in finding creative solutions to problems. Sustainability affects us as citizens, business managers, parents; it is a holistic issue and thus the solution this time will not come from governments and political agreements. Businesses and consumers play a relevant role now in building a sustainable future for all of us. But solutions will require collaboration and transparency. This is a new paradigm and consequently new opportunities also arise. Sustainability presents a threat to firms but opens opportunities too and even ecological issues must be considered optimistically as opportunities for success (DeSimone, Popoff, & World Business Council for Sustainable Development., 2000).

From a business perspective, sustainability has been defined as meeting the needs of a company´s stakeholders without compromising its ability to meet the needs of future stakeholders as well (Dyllick, Hockerts, & Thomas Dyllick, 2002). Likewise, sustainability was defined by the Centre for Sustainable Enterprise as a way of doing business that creates profit while avoiding harm to people and planet (Hult, 2010).

This said, without sustainability I believe there is no future for businesses. Lubin (2010) stated that sustainability is the new business megatrend, because it presents inescapable strategic imperatives for corporate leaders (Lubin & Esty, 2010, p. 1). They go further declaring that managers can no longer afford to ignore sustainability as a key element of their long-term competitiveness. Moreover, I believe that the only organizations that will survive are those which adapt more rapidly to this new environment, learning how to manage with less or at least different resources. Only such organizations are truly sustainable businesses and therefore will endure.

At the same time, managers across all industries and countries are at present more and more in search of new and differentiated ways to outstand from their competitors and create original value propositions. The good news is that sustainability can be a great source of sustainable competitive advantages. Many corporations of all sizes have succeeded already in this path. In many other cases, sustainability practices have permitted an improvement in the financial results of companies. Still, measuring the effect of sustainable policies is not easy. Elkington (1998) introduced the triple bottom line accounting in measuring sustainability, incorporating three dimensions of performance: social, environmental and economic. Measuring each of the three categories is a challenge to putting the triple bottom line into practice. Elkington goes further stating that the three dimensions are closely interrelated: for instance, environmental initiatives may imply greater profitability, e.g. reducing waste or packaging can also reduce costs. Profitability is therefore closely linked with sustainability. In a research among business managers in the US, performed by MIT Sloan Management Review, The Boston Consulting Group, and the UN Global Compact, 28% of the interviewed top managers mentioned they had improved profitability through their environmental or social sustainability policies (Kiron, D; Kruschwiths, N; Haanes, Knut;Reeves, M; Kell, 2015). Furthermore, some authors consider sustainability as imperative for business success. In fact, Elkington (1998) presented sustainability as a millenarian event that will turn everything upside down in the business world (Eklington, 1998).

Research has found that managers tend to prioritize the economic dimension of sustainability (bottom line and flow of money) over social and environmental (Bansal, Pratima; Roth, 2000), although they are often related (Hall, TJ; Slaper, 2011). If a business is socially and environmentally sustainable, but gives no profits, it will not endure. Extreme competition nowadays makes that the opposite works too: a very profitable business that does not care about social or environmental issues will probably not endure either.

There is consensus at present on the fact that sustainability measures can help businesses reduce costs, for instance through energy cost savings, although the agreement is not so strong with regard to sustainability being a tool to increase sales. In fact, there are quite a few examples of

marketing failures when trying to attract consumers to 'green' products charging an important price premium. Actually, researchers found no positive relationship between corporate sustainability efforts and consumers` willingness to pay, but did find positive connexions between corporate sustainability and stock market performance (Schrettle, Hinz, Scherrer-Rathje, & Friedli, 2014).

For this reason, I suggest that the current focus should be reducing costs rather than increasing sales through sustainable practices, although this may change in the near future. Sustainable polices in firms nowadays are mostly focused in search for efficiencies and maybe risk prevention (e.g. resource scarcity), but I believe consumers will soon openly demand companies a higher level of responsibility.

1.1 Sustainability strategies have very diverse drivers and executions

In the last 10 years corporations have used sustainability policies to maintain and increase profitability, enhance brand reputation, talent management and risk prevention, thus increasing competitiveness and also cultural legitimacy (Warshawsky, 2015).

Although businesses can take steps to address unsustainability for reasons that range from profit to real concern about sustainability (Kopnina, 2015), the strongest motivation for corporations is saving money and reducing costs (e.g. from energy efficiency and waste management strategy). Besides, with regard to environmental business initiatives, top management commitment was found by Chabwoski et al. (2011) to be the most influential driver.

Corporate social responsibility demonstrates a win-win-win scenario, as benefits are realized by society, employees and corporations (N. C. Smith, 2009). Conforming to socially responsible practices enhances the strategic position of firms, through reputation first of all and this is valid both for for-profit and not-for-profit organizations. Both types of corporations have reasons to be socially sustainable (N. C. Smith, 2009). Employees have a better self-image when working for a socially responsible company, thus sustainability can help not only hiring talented employees but also retaining them. There are different drivers for corporations to be sustainable; these can be exogenous, such as environmental regulation or market drivers, or endogenous, such as the culture, resources and strategy of a firm (Schrettle et al., 2014) and this implies many different possible executions of sustainability in corporations.

From a marketing point of view, sustainability can be well-defined as the ability to sustain competitive advantages (Harik, EL Hachem, Medini, & Bernard, 2015). Actually, we can further stress the concept of sustainability by adding a marketing philosophy. Thus, briefly explained, market focused sustainability means adding the consideration of multiple stakeholders and corporate social responsibility to market orientation (Hult, 2010). In other words, if marketing is about satisfying consumer needs and building profitable relationships with them, sustainability marketing means building relationships not only with the consumers but also with the social and the natural environment. Sustainability marketing ultimately aims at creating customer value, social value and ecological value (Belz, 2006, p. 1).

Opposed to limiting sustainable marketing activities to the development of green alternatives addressed to 'green conscious' consumers, Achrol and Kotler (2011, p. 45) emphasize a new philosophy for firms that proactively 1) communicate the harmful side effects of wasteful consumption, 2) grow the segments of environmentally conscious consumers, by developing superior products at standard market prices, and 3) demarket - countermarket certain products, technologies, and marginal consumer segments. They state that in the new environment growth is not a panacea and customer care means acting on behalf of the customer`s long term interests. This idea helped me focusing my Ph.D. research on waste minimization policies rather than sustainable product development.

1.2 Sustainable supply chains & systems

Sustainability embraces all the different stages in the supply chain: suppliers, producers, logistics, retailers, food service, etc. they are all affected. The effects of production and consumption must be considered widely and globally: businesses and consumers should be aware of the impact that the products they produce and consume have, considering from the production of raw materials up to how waste is discarded after consumption. Moreover, collaboration among the different players, together with board engagement, have been considered critical by scholars for sustainability success (Eklington, 1998).

A sustainable supply chain was defined by Hassini et al. (2012) as the management of supply chains aiming to maximize economic returns while minimizing environmental impacts and maximizing social wellbeing. They acknowledge sustainable supply chain management means dealing with possible conflicting interests (Hassini, Surti, & Searcy, 2012).

It has to be acknowledged that the food system is very complex (Heller & Keoleian, 2003). Food supply chains should be considered as a system of inter-related stages in which initiatives taken in one step should not be contemplated as independently but as part of a whole (Gitz, 2015). This is especially relevant if we consider that in order to reach their sustainability standards and commitments, corporations often need to force their upstream suppliers to adapt sustainable practices (Hassini et al., 2012). Additionally, due to the fact that food supply chains have significant sustainability implications (Yakovleva, Sarkis, & Sloan, 2012), external stakeholders increasingly put pressure on companies requiring them to accomplish sustainability commitments exceeding regulatory requirements (Grimm, Hofstetter, & Sarkis, 2014). Corporate sustainability strategies will increasingly adopt open-source approaches that engage external stakeholders (Lubin & Esty, 2010).

1.3 The efficiency of the food system must be improved

Having in mind the need to guarantee food security globally and being food demand at present - and foreseeably in the next 40 years -a major driver for global environmental footprint (Tilman et al., 2001), increasing the efficiency of the whole food system becomes a high priority for sustainable development.

Sustainable food systems should be based upon resource use efficiency in order to minimize its impact on the environment (Mathijs, 2012). Efficiency will be achieved by adopting the 3R *'Reduce, Reuse, Recycle'* mind-set in products and services design (Gunasekera, 2015; Kleindorfer, 2005). The *Reduce* aspect is the highest priority in the waste management hierarchy – meaning it is the best environmental option - and refers to waste prevention (Yano & Sakai, 2015). We shall refer to *Reduce* as the reduction of waste, material and energy use throughout the product life cycle (Harik et al., 2015) and means, for instance, to prevent food waste caused by over-cooking or over trimming. *Reuse* would include using unused food to feed people – e.g. donations to local charities – or animals. Finally, *Recycle* would mean compost or converting to fuel (Birne, 2010). Joshi (2006) goes further by adding *Recover*, *Redesign* and *Remanufacture* to Kleindorfer et al. 3R`s, stating that the 6 R´s should be accomplished nowadays in order to gain market acceptance. Applying the waste hierarchy in the context of food waste shows that prevention, through minimization of food surplus and avoidable food waste, opens up the greatest opportunities in increasing the efficiency of the food supply chain (Papargyropoulou, Lozano, K. Steinberger, Wright, & Ujang, 2014).

Paradoxically, in a context of increased competition for more and more scarce resources such as land, water and energy (Tilman et al., 2001), food waste has increased significantly in the last years and if nothing is done, will continue increasing in the near future (Buzby & Hyman, 2012) due to several factors such as industrialization and the increase of wealth which lead to more diversified diets, the increase in prepared food and out of home consumption - that results in increased physical distance of people from food - and lastly, the shift from local to regional and to global foods. It is

therefore becoming urgent to reverse the trend of increased food waste (Thyberg & Tonjes, 2016). As a result of unsustainable production and consumption it has emerged as one of the world´s most critical issues (Warshawsky, 2015). For this reason, food waste arises as a problem that must be tackled appropriately in order to guarantee sustainable growth in our planet. Institutions, corporations and consumers must unite efforts on behalf of their responsibility to feed nine billion people by 2050 (Finn, 2014), and some authors even point to the fact that research should not merely observe and explain the empirical phenomena but aim to help change the status quo (Seuring & Gold, 2013).

Food waste is a misuse of resources with relevant implications in the three spheres of sustainability. Furthermore, Mena, Adenso-Diaz and Yurt (2011) highlight that food waste is a global issue. It is ethically inacceptable when almost 800 million people at present suffer hunger or are undernourished (FAO, 2015) and scholars have highlighted that reducing food waste would help feed the hungry (Henderson, 2004; Stuart, 2009). From the environmental perspective, food waste concerns both for the production of methane and pollution (Griffin et al., 2009; Hogg et al., 2007; Stuart, 2009) and for inefficient use of natural resources (Forkes, 2007; Lundqvist et al., 2008;Nellman et al., 2009; Stuart, 2009). Moreover, food waste often ends in landfills which is the most unsustainable way of discarding waste (Mena, Adenso-Diaz, & Yurt, 2011). With regard to the economic implications of food waste, the loss of land, water and biodiversity, together with the negative impacts of climate change, represent huge costs to society that are yet to be quantified (Ventour,2008); FAO (2013).estimated direct cost of food waste in US $ 750 billion, equivalent to the GDP of Switzerland!

Indeed, the global food system still has to solve deep problems in order to be truly sustainable. According to FAO Food Wastage Footprint study roughly we waste one-third of the food produced for human consumption, that is over 1,3 billion tons per year globally (FAO, 2011). Slightly over 50% of global food loss and waste is generated in developed countries where we waste more at the consumption and distribution stages rather than at the first steps of the food supply chain (Lipinski et al., 2013). Needless to say, waste at the distribution and consumption stages is relevant as it has gone through all the previous stages in the supply chain, accumulating use of resources. In the EU 100 million tons of food are wasted annually (Canali, Östergre, & Amani, 2014) - around 157 kg per capita every year (European Commission, 2010) - and if nothing is done, it is expected to rise up to 126 million tonnes by 2020 (EWWR, 2014). Spain ranks 10th in the European Commission ranking of food wasted in the EU, with 127 kilos per capita (EWWR, 2014). Nevertheless, it is a very difficult issue to address for managers, as its costs most of the times remain 'hidden' (Mena et al., 2011) and they are often undervalued and underreported (Binyon, 2007). Different studies have shown that the food service industry is the second source of waste after households, which account for the biggest amount of waste (40%) in developed countries. Reducing food waste would aid in the path towards a more sustainable global food system as it would imply a more efficient (and ethical) use of scarce natural resources. This is particularly challenging, as it is very closely related to individual behaviour and cultural attitudes toward food in developed countries (Godfray, Crute, et al., 2010).

Food waste has been the objective of numerous studies across industries, and despite the difficulty of comparing data from different countries and authors, research show striking data. In the food service industry, for instance, data range between 15 to 66% of prepared food being wasted (Sonnino & McWilliam, 2011).

As mentioned before, food waste has implications in all three dimensions of sustainability. Wasting food while there are still millions of hungry people arises deep ethical problems. What is more, it could even lead to a future food crisis (Nellemann, 2009a). Moreover, food waste disposal to landfills produces methane, a harmful greenhouse gas, not to mention the inefficient use of scarce natural resources such as water, land and energy used in the production of wasted food. Last but not least, food waste has an economic impact and its reduction would lead to savings both to organizations and individuals. This is especially relevant in an industry such as food service,

traditionally known for its low margins.

Food waste is a crucial challenge to improve the sustainability of the food system, although still few people are aware of its relevance and dimension. I will try with my thesis to shed some light on how much food is wasted and how it can be measured. Furthermore, I aim to unveil best practices or interventions that may become appealing to business and institution managers by helping them achieve their goals, both professional and why not, personal too.

1.4 Food waste prevention and reduction initiatives

Comprehending food waste drivers in an integrated perspective throughout the food supply chain is essential to find solutions and consequently prioritize initiatives for action (HLPE, 2014; Canali et al., 2014, 2015; Garrone et al., 2014). Nonetheless, the lack of awareness on food waste is one of the reasons for the slow progress in reducing food waste because few people understand the scope of the problem (Finn, 2014). Furthermore, due to the fact that food waste is produced at all stages of the food supply chain, solutions to its reduction should include multi-stakeholder collaboration (Halloran, Clement, Kornum, Bucatariu, & Magid, 2014), taking into account that initiatives to reduce food waste in one stage could negatively affect another stage (Engström & Carlsson-Kanyama, 2004).

The development of a food waste measurement reduction protocol has been highly recommended by researchers like Lipinski et al. (2013) who go further by suggesting the need to link it to setting reduction targets and supporting collaborative initiatives to reduce food waste (Lipinski et al., 2013).

There is a growing awareness of the potential positive impact that reducing food waste would have on the environment (greenhouse gas emissions, energy, water and soil more efficient use, etc.) although it is acknowledged that it is a complex issue, as it is often related to behaviours deeply rooted to cultural factors.

While acknowledging the food service sector does not generate the highest amount of food waste in developed countries, addressing food waste in the food service sector can be a quick win as we can tackle waste from a high number of people at the same time. This is specially touching when we consider that over two thirds of food waste in the food service sector in the EU has been estimated to be avoidable (Beretta, Stoessel, Baier, & Hellweg, 2013).

Scholars agree on the fact that reducing food waste will not only optimize food service firms` profitability but will also contribute to improve foodservice quality and consumers satisfaction (Ferreira, Martins, & Rocha, 2013), and therefore can be seen as a way to improve the competitiveness of the industry. Researchers (e.g. Betz, Buchli, Göbel, & Müller, 2015)(e.g. Betz, Buchli, Göbel, & Müller, 2015)(e.g. Betz, Buchli, Göbel, & Müller, 2015)(e.g. Betz, Buchli, Göbel, & Müller, 2015)(e.g. Betz et al., 2015; Engström & Carlsson-Kanyama, 2004; Falasconi, Vittuari, Politano, & Segrè, 2015; Ferreira et al., 2013; Östergren et al., 2014) (Betz et al., 2015; Engström & Carlsson-Kanyama, 2004; Falasconi et al., 2015; Ferreira et al., 2013; Östergren et al., 2014)(Betz et al., 2015; Engström & Carlsson-Kanyama, 2004; Falasconi et al., 2015; Ferreira et al., 2013; Östergren et al., 2014)(Betz et al., 2015; Engström & Carlsson-Kanyama, 2004; Falasconi et al., 2015; Ferreira et al., 2013; Östergren et al., 2014)(Betz et al., 2015; Engström & Carlsson-Kanyama, 2004; Falasconi et al., 2015; Ferreira et al., 2013; Östergren et al., 2014)mention multiple strategies that could be implemented to reduce food wastage in food service companies, such as implementing the pre booking of meals, training staff, offering various portion sizes, temperature control issues and improved storage systems, technology improvements and innovation, among others and they mostly agree on the fact that food waste is closely related to individual behaviours and cultural issues. For this reason, one relevant way to foster responsible citizenry and promote sustainable habits is to harness the capacity of schools to create change. Educating for future sustainable consumers today can make a significant change in the sustainability of the entire food system. Schools can empower the next generation to make

changes that may become essential in the near future.

I focused my research in the food service sector in general at the first stage, and more precisely in school canteens at the second stage, due to the fact that they are a relevant source of food waste. Schools have been identified as being in a primary position to offer education on nutrition and sustainability, being able to influence present and future consumption patterns. This is very relevant, as food consumption patterns heavily affect the sustainability of the global food supply chain (Benvenuti, De Santis, Santesarti, & Tocca, 2016).

1.5 Motivation

My final goal with this thesis is to try to contribute towards a more sustainable food system through enhancing business practices that could improve the sustainability of food corporations globally. I aim to shed light on sustainability related business opportunities as I believe a win-win situation is possible: companies and institutions can benefit from certain practices and policies at the same time that they do good for the society and the environment. Moreover, such practices could become a true sustainable competitive advantage for some businesses or at least a way to improve their profitability (economic sustainability) through different mechanisms which might comprise cost reduction, sales increase, customer and staff engagement, brand positioning (differentiation vs competitors), etc.

Food waste statistics and facts are touching. I think it is ethically unacceptable to discard such a big amount of food while we have not yet solved the hunger or undernourishment problem in our planet. The result of this research should allow business and institution managers a better understanding of unsustainable practice drivers and hence could help food corporations move towards sustainability. It was my purpose to shed light on new business practices required for food corporations in order to embrace sustainability and therefore long term success.

Food waste is often not managed due to its low visibility. The lack of awareness on food waste is one of the reasons for the inaction from corporations and institutions, as only a few people are really aware and fully understand the scope of the problem. Through my thesis, I also aim to help improving the visibility of food waste as, from my experience, managers tend naturally to apply correction or minimization initiatives whenever they become aware of waste as they then realize they are not being efficient and quite rapidly and naturally tend to act aiming to reduce inefficiencies. Furthermore, food waste costs usually remain hidden and are often undervalued and underreported (Binyon, 2007). With the aim to help uncovering these hidden costs, I developed in my second study a food waste auto assessment tool, comprising a measurement protocol for school canteens.

Secondly, as I found no consensus among scholars nor among managers on the terminology related to food waste. I also tried through my research to shed light on the different conceptualizations related to or included in food waste. This conceptualization eases the understanding of the optimal intervention to address food waste.

To sum up, I had two main motivators with my thesis. First, to validate the hypothesis that there are business opportunities related to sustainability and shade light on how can sustainable practices in food corporations be enhanced. Secondly, I chose the food waste issue for its strong ethical dimension. The reason for which I decided to study school canteens is double-fold. School canteens constitute an opportunity for nutrition and sustainability education which would have a positive impact both today (reduction of food waste) and tomorrow (more educated and concerned consumers in the future).

1.6 Document structure

The doctoral thesis is composed by three studies. The first one aimed to understand the relevance of food waste in the food service sector in Spain, categorize what is considered food waste and describe

its drivers as well as reduction best practices. Through the second study we developed an auditing tool to help measuring food waste in educational institutions. And, finally, in the third study we list and prioritize food waste reduction interventions based on school managers´ willingness to adopt them.

1.6.1 Opening up invisible waste in food service

We conducted an explorative study among managers of corporations that play a role in food waste generation in the food service sector. We used primarily qualitative data from in-depth interviews in 12 companies and 2 institutions in search for insights on food waste, as well as a survey among 20 corporations with the goal of quantifying it. The purpose of this first study was to identify food waste drivers in the food service channel and to describe best practices to minimize it.

In order to reach this goal, we designed a research with an inductive approach in two parts. The first part was qualitative through semi-structured, individual interviews with managers in different companies. The sample was made up of nine food service, market leader companies, two food production corporations (bakeries) and one fresh food wholesaler that distributes fruit, vegetables, fish and meat to the food service sector. Additionally, we included a non-for-profit organization that plays a relevant role in the collaboration between suppliers and retailers, as well as a food bank.

Consistent with the literature, we confirmed that there is no consensus on the definitions related to food waste. With our research, we shed light on the different classifications and typologies of food waste, observing three main groups. First, based on where and when waste is generated: pantry, kitchen or service. The outcome of this classification is a first categorization of waste: i.e. damaged or out of date ingredients, kitchen waste, served but not eaten food or cooked but not served food. A second classification was based on the level of potential avoidance and where waste ends: unavoidable waste (bones, shells, peels, …); avoidable or partially avoidable waste (plate waste, display leftovers…) and avoided waste (which is food derived for animal feed or industry derivatives). A third classification is based on how relevant it is for business managers, distinguishing between pre-consumer and post-consumer waste. Pre-consumer waste has a direct impact on the Profit & Loss statements of the business and thus is relevant for management, while post-consumer waste is often considered consumer´s responsibility and, as firms have already cashed it, it is normally not a priority to managers, who are usually efficiency and profit driven.

Our first classification is useful to design waste reduction interventions as it focuses on where and when waste is produced. The second classification is also useful, as it sheds light on the opportunity to apply reduction measures (a high percentage of avoidable or partially avoidable waste will mean a high improvement opportunity), as well as on how well the corporation is currently managing waste (percentage of avoided waste). Finally, the third classification is also useful to determine adequate interventions: increasing pre-consumer waste visibility will enhance reduction measures for the sake of efficiency and profitability, whereas post-consumer waste must be tackled through awareness and educational campaigns. Low valuation of food is a significant driver of waste, exemplified by the fact that side dishes and accompaniments are often left by diners.

We quantified food waste in Spanish food service institutions through our survey in 13,5 % of the volume of food ingredients managed by the companies in our sample, being fruits and vegetables (25%), bakery (15%) and cooked dishes the categories with higher waste rates. A limitation of this first study is that these figures are declarative, thus not measured directly by us. Although our results are consistent with the literature, low visibility of food waste might have biased managers` estimations.

Our research confirmed that food waste drivers strongly vary depending on the stage of the process. For this reason, we grouped suggested interventions and best practices based on when and where in the process it is produced. Some of the suggested interventions are listed here:

1) Procurement Stage:

- Advanced demand planning software
- Km. Zero procurement practices
- Intelligent menu planning
- Collaboration with suppliers

2) Storage:
   - Inventory management systems
   - Improved expiry date control
   - Use of pre-prepared food
   - Packaging technology to preserve leftovers
3) Transport:
   - Flexible supplier delivery call frequency
   - Rigorous temperature control
4) Cooking:
   - Employee training and consciousness on sustainability and food waste
   - Increased waste visibility
5) Service
   - Flexible portions
   - Optional side dishes
   - Plate waste audits
   - Consumer awareness campaigns
   - Offering take away containers

Natural product characteristics such as shelf life, demand fluctuation and storage requirements influence waste generation and, thus, waste levels vary significantly depending on the type of food. Accurately predicting demand and rigid food procurement specifications are relevant causes of food waste.

We suggest a short list of best practices to minimize food waste in the Spanish food service sector, grouped in three categories: (1) Improved management processes, (2) Increased visibility and awareness, and (3) Collaboration initiatives.

The higher the 'visible' cost of food waste is for firms, the higher their interest will be in reducing it. Whenever minimization measures are not taken, it is usually due to one of the following issues: (1) Low real awareness of waste; (2) Marketing issues also related to economic results such as when products must be displayed to enhance sales, like for instance in a bakery outlet, and (3) Waste produced once food has been sold (post-consumer waste).

Opportunities for reducing food waste in food service organizations can be summarized in two blocks: firstly, increasing the visibility of food that is discarded will reduce pre-consumer waste; secondly, addressing plate waste through educational and awareness campaigns will help reducing post-consumer waste.

1.6.2 Tracking food waste at school canteens. A food-waste self-assessment tool design

The institutional catering industry and very particularly school canteens, embody a significant source of food waste and represent an ideal opportunity for minimizing food waste foot print (Wilkie, 2015). Being schools a natural place for education, and taking profit of the near universal attendance of school by children, addressing food waste at school canteens is essential in order to improve the sustainability of the food system. However, regulators, school managers and catering companies do not often focus on reducing food waste. Instead, they usually focus more on the nutritional values of lunch menus rather than on the nutritional value of effective food intake.

Food waste is 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 the global health situation are emerging (Mathijs, 2012): obesity and overweight rates are rapidly increasing in almost all developed countries specially among children (Belot & James, 2011). Schools provide a key avenue to both preventing and reducing the prevalence of childhood overweight (Jacko,Dellava,Ensle & Hoffman, 2007) as well as to improve habits on nutrition, through education on nutritional values and increasing awareness on food relevance (Benvenuti et al., 2016). Moreover, food waste at school canteens could be reduced through educating students and staff in order to change behaviors that cause food waste (Wilkie, 2015) . Several researches have been performed in order to quantify the amount of food that is wasted daily at school dining facilities showing a considerable variation between the different schools, typically ranging between 20% to 50% of food served being wasted (Wilkie, 2015). This takes us to the starting point of this second study which is in which way can food waste be measured and tracked in school canteens.

Considering the lack of uniformity regarding school meals in Europe, this is particularly relevant in Spain where lunch is culturally the main meal of the day, opposed to north European countries where dinner is considered the main meal of the day.

The goal of this study is to provide schools and educators, as well as catering companies with a tool that unveils and quantifies food waste at school canteens while at the same time facilitates the implementation of reduction measures and result tracking. A secondary objective of the study is to describe drivers that contribute to food waste and identify possible strategies that could lead to its reduction.

In order to achieve this goal, we designed an exploratory research in two phases. First, we collected data through qualitative research with a range of stakeholders in order to understand the factors that generate food waste at school canteens and obtain insights, from which a first draft of the tool was designed. We conducted semi-structured, individual interviews to 12 managers and staff of 9 different institutions and collectives that play a role in school meals: school administration employees, catering providers' personnel (administration, buyer, cook and other staff), teachers as well as primary and secondary school students. Once the assessment tool was pre-designed, based on the findings of this first stage of the study, and in order to validate and improve it, we put it in practice in four of the participating schools in the former phase, with over 2,900 pupil participants and measuring food waste from over 10,000 pupils' lunches in order to test its performance and improve its deficiencies. The trial lasted several consecutive weekdays with the objective of comprising different menus and therefore avoid potential bias due to meal acceptance. The schools were selected including both public and private, so as to ensure medium to big size schools and a mix of socio-economic status as well as different catering arrangements.

The outcome of our research is a novel self-assessment auditing tool to be used by schools and catering organizations in order to easily measure food waste produced at school canteens. The benefit of using a standardized measurement is that results can be compared among schools as well as tracked by performing regular audits in one school.

Based on our research, we grouped the information to be measured and tracked when auditing food waste at school canteens, into four categories (accuracy of the planning system, physical measure of waste, waste destination and economic cost of food waste), and described their related key performance indicators, such as the deviation rate between planned and served meals, aggregate and selective weight of food waste, the number of zero waste trays (as a percentage of total trays), waste destination or use and, finally, the economic cost of food waste.

Our paper provides new contributions to the literature on food waste. Firstly, a standardised and easy to implement self-assessment tool is developed to be implemented at school canteens. Secondly, it sheds light on the potential good acceptance that sustainable initiatives may get from school managers and staff. Finally, it relates food waste drivers to key performance indicators that would help managing potential initiatives to address them.

Food waste was weighted separately, depending on where it had been produced (pantry, kitchen, service or plate waste), and also differentiating whether it was avoidable (e.g. out of date

ingredients, plate waste) or unavoidable (e.g. bones, peels) waste. We placed 6 different signalled bins in the designed collection stations and weighted waste aggregately at the end of each meal.

Through the implementation of the tool, academics will have further relevant quantitative data and visibility to food waste, a field of information which is not widely available. Moreover, scholars could adapt and use the tool in different countries and environments in order to obtain metrics and insights on food waste and benefit from benchmarking and shared experiences under homogenous criteria and standardized concepts.

We aim to provide schools and catering companies with a set of principles and tools that unveil and quantify food waste at school canteens. Food waste drivers can be grouped in three areas: first, those features related to the institution culture and values, such as top management perspective on sustainability. Secondly, certain inadequate management practices can be the cause of food waste (i.e. deficient kitchen-school communication). Poor infrastructures such as kitchen facilities or canteen layout were also found to be a significant relevance when analysing food waste.

We concluded from our research that a waste audit should record information on four areas:

1) Accuracy of the planning system, tracked by the rate between planned and real number of diners as a key performance indicator (kpi).
2) Physical measure of waste, recording aggregate food waste by type of food.
3) Waste destination
4) Economic cost of food waste: estimation in value (€, $) of the cost incurred by the loss.

It is necessary to establish clear, user-friendly methodologies and tools to measure the results of firms´ progress toward sustainability (Székely & Knirsch, 2005). Our study suggests that although there is low awareness on the amount of food wasted at school canteens, managers and staff are highly interested in the topic, and would be willing to implement audits and reduction initiatives. The case study also showed that the developed tool is easy to implement by educational centres and not disruptive.

Standard criteria for measuring catering food waste was novel in the literature, particularly as we include both pre-consumer and post-consumer waste, as categorized in our previous study. By relating food waste drivers to key performance indicators, we intend to help institutions and catering businesses to address this relevant issue and thus, help them along their path towards more sustainable organizations.

1.6.3 Addressing Food Waste at School Canteens

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. Catering operations are influenced by different policies at all levels, and they 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). Nevertheless, within the food service sector, catering professionals, food procurement officials and chefs are in positions of responsibility and influence, they continually make decisions that help to shape, guide and control the food system (Goggins & Rau, 2015). Being food waste closely related to misbehaviours such as undervaluing food (Principato, Secondi, & Pratesi, 2015), education becomes crucial, and therefore, schools can play a key role in addressing food waste.

School cafeterias are a quite controlled environment where educational campaigns offer unique opportunities, which could be incorporated into existing curricula, to minimize food waste, to divert this food waste from landfills, and to transform these materials into energy and soil amendments through composting or anaerobic digestion, etc. (Wilkie, 2015).

The goal of this research was to understand how can food waste be addressed at school

canteens so that schools can contribute to more sustainable food systems. In order to reach this goal, we first analysed the different business models operating at present to supply school meals and the main types and causes of food waste at school canteens. Next, we identified initiatives and practices to minimize food waste and prioritized them based on their potential acceptance by school principals.

Due to the complexity of this objectives, we designed a mixed methods research approach in three stages, including semi-structured individual interviews to managers and staff of catering institutions and schools, waste audits at four school canteens as well as a quantitative survey among school principals. Our sample was composed of 21 qualitative in-depth interviews in the first stage, the measurement of food waste from over 10,000 pupils' trays and the analysis of 420 responses to our quantitative survey.

Overall food waste was estimated in our research to be between 60 and 100 grams per pupil and day. Plate waste was the highest source of food waste at schools and as we observed in our study it is strongly influenced by the school`s educational perspective. In fact, we concluded that schools that include sustainability in their pedagogical curricula tend to generate lower food waste in their canteens. It was proven that school principals, canteen supervisors and teachers play a relevant role in facilitating, designing and executing waste minimization interventions.

We classified food waste drivers into three categories. First, behavioural factors, among which the principal`s standpoint towards food waste and sustainability in general outstands. Second, issues related to the catering business model, operational and managerial issues and, finally, other determinants such as resource availability and school facilities. We used this classification to group key recommended interventions too. Suggested initiatives related to behavioural factors include awareness and educational campaigns, waste audits, friendly competitions among pupils and the use of 'waste-calculators' to estimate the economic cost of food waste. Optimized operations may include considering food waste in menu planning, offering pupils the chance to choose among meal options and improved communication among catering providers, school staff and students. With regard to the different catering business models, the focus when aiming to reduce food waste must be put in different stages depending on the model, as we reveal in our study. Finally, regarding resource allocation, best practices may include hiring a specific meal supervisor team instead of teachers supervising meals – we found that low plate waste rates at school canteens are highly related to supervisors´ control and staff attitude -, training programs or the use of physical systems to minimize noise or improving the decoration of the dining room. Additional findings of our study include the fact that secondary school pupils in Spain tend to leave uneaten up to twice the amount of food left by primary graders.

Preferred interventions by school principals were diverse and showed different perspectives. The following interventions had the highest scores: 51% of the respondents agreed on the fact that increasing the number of caretakers at lunchtime would help reducing plate waste, 45% would want to enhance compost or food donations while performing workshops in order to teach pupils how to peel fruit was chosen by 43% of the respondents.

Although only 15% of the respondents agreed with the statement 'A lot of food is wasted at school', interestingly, 52% stated the need of measuring waste and said they would be interested on performing waste audits.

As a final conclusion of this study we confirm the relevance of school cafeterias in the path towards more sustainable present and future food systems and the human factor arises as the most relevant when aiming to minimize food waste.

CHAPTER 2

OPENING UP THE INVISIBLE WASTE IN FOOD SERVICE

Sustainable development was defined by the World Commission on Environment and Development as "meeting the needs of the present without compromising the ability of future generations to meet their own needs' (Brundtland, 1987, p.39). Under this context, the food system is closely related to sustainability as production must augment to meet the needs of future increased and more affluent population demand (FAO, 2011) resulting in increased competition for more and more scarce resources.

2.1 Introduction

According to FAO Food Wastage Footprint study roughly we waste one-third of the food produced for human consumption, that is over 1.300 million tons year globally. A sustainable food system should be based on resource use efficiency (Mathijs, 2012) in order to minimize its impact on the environment (Mena et al., 2011) and by all means, waste has a crucial role to play here. Reducing food waste can represent part of the solution to food security and environmental challenges, namely the need to feed more people while making the food value chain more environmentally sustainable and resilient (Garnett, 2008).

Food waste has increased in the last years and if nothing is done will continue increasing in the near future (Buzby & Hyman, 2012). For this reason, as observed by Warshawsky (2015), it has emerged as a critical issue attributable to unsustainable production and consumption. Both institutions and scholars (e.g. FAO, 2011; Göbel, Langen, Blumenthal, Teitscheid, & Ritter, 2015) agree that food produced for human consumption but finally discarded means an overspending of natural resources. Having in mind the need to guarantee food security globally and being food demand a major driver for global environmental footprint (Tilman et al., 2001), increasing the efficiency of the whole food chain becomes a high priority for sustainable development.

Under this context, the objective of our research it to identify food waste causes and describe best practices to reduce it in Spain, through an explorative study in which managers of 12 corporations and 2 institutions were interviewed. Moreover, we developed a questionnaire to

quantify the food waste which was filled by 20 corporations. With regard to our scope, we focus the research on food waste management from a broad perspective in the food service sector, which as described by the EC, comprises the preparation of ready-to-eat food for sale to individuals and communities including catering and restoration activities in the hospitality industry, schools, hospitals and businesses (European Commission, 2010, p25).

2.2 Literature Review

2.2.1. The concept of food waste

There is no consensus among scholars on the definition of food waste (Lebersorger & Schneider, 2011), making it difficult to compare the findings of studies on the management of surplus food between different countries (Paola Garrone, Melacini, & Perego, 2014). Numerous terms are often used as synonymous, such as food waste, food loss, biowaste (Thyberg & Tonjes, 2016) and kitchen waste while at the same time the same word is often used with different meanings (Gjerris & Gaiani, 2013). One of the most widely accepted definition of food waste was given by FAO as edible products going to human consumption but which fortuity gets out the human food chain, being instead discarded, lost, degraded or consumed by pests (FAO, 2011).

Parfitt (2010) discriminates three food waste definitions from this former one. He recalls Stuart (2009), adding to this former definition of food waste all edible material intentionally used to feed animals or used as a by-product of food processing diverted away from the human food (Stuart, 2009). This approach distinguishes "planned" non-food uses to "unplanned" non-food uses (FAO, 2011).

Recently, EU project FUSIONS (Östergren et al., 2014, p. 6) defined food waste as ""*Food waste is any food, and inedible parts of food, removed from the food supply chain to be recovered or disposed (including composed, crops ploughed in/not harvested, anaerobic digestion, bio-energy production, co-generation, incineration, disposal to sewer, landfill or discarded to sea)*".
Table 2.1 shows different conceptualizations and terms found in the literature relative to food waste additional to the above-mentioned.

Table 2.1: Concepts related or included in food waste

Author, year	Concept	Definition
Kantor et al., 1997	Food loss	Food losses usually refer to edible food, lost at any stage of the supply chain, such as meats, bread, discarded or unserved restaurant-prepared food, or products that are unmarketable for aesthetic reasons, but otherwise edible and safe
Grolleaud, 2002	Food loss	Food loss refers to the decrease in food quantity or quality, which makes it unfit for human consumption
Parfitt, Barthel, & Macnaughton, 2010	Food loss vs FW	Food losses: waste produced at the beginning of the FSC: production, postharvest and processing stages FW: when appearing at the end, retail and final consumption Post-Consumer Waste: FW produced at households.
Gustavsson et al. 2011	FW	FW: Any edible food that is lost during any phase of the food system
Bloom, 2011	FW	FW occurs when edible items go unconsumed as a result of human action or inaction, often result of a decision made by business, governments or consumers.
Papargyropoulou et al 2014	Avoidable Vs Unavoidable	Avoidable FW: foods or parts considered edible by the vast majority of people) and Unavoidable FW: waste arising from food that is not edible under normal circumstances, fruit skin, apple cores and meat bones. He recalls this classification is subjective in a way as depends on factors such as culture, religion, etc.

From the review of the different concepts and definitions, we consider that 1981 FAO`s definition seems still current as most researchers reference it; however, food waste definition has

evolved, settled at the same time while new related terms have appeared although authors have not reached a consensus. Buzby & Hyman (Buzby & Hyman, 2012) point out that there is a trend to use wider definitions of food waste.

2.2.2 Food waste as a global issue

Mena, Adenso-Diaz and Yurt (Mena et al., 2011) highlight that food waste is a global issue not only for ethical reasons - reducing food waste would help feed the hungry (Stuart, 2009) - but also for the environmental consequences of inefficient use of natural resources (Lundqvist, Fraiture, & Molden, 2008; Nellemann, 2009b; Stuart, 2009) - the production of methane and pollution (Griffin, Sobal, & Lyson, 2009; Hogg & Barth, 2007; Stuart, 2009) as well as for its economic impact through the supply chain (Ventour, 2008). Food waste arises as a problem that must be tackled appropriately in order to guarantee sustainable growth in our planet.

Slightly over 50% of global food loss and waste is generated in developed countries where we waste more at the consumption and distribution stages rather than at the first steps of the food Supply Chain (Lipinski et al., 2013). In the EU 89 million tons of food are wasted annually, and this figure is projected to increase to 120 million by 2020; Spain was, with 7.7 million tons, the sixth country in the EU with higher waste being fish, fruit & cereals the categories with stronger level of waste (European Commission, 2010). Recently Canali et al. (2014) estimate that EU-28 produce yearly about 100 M tons of food waste.

Several researchers have estimated the food service industry as responsible for between 10% and 20% of the total food wastages in the EU countries, claiming that over two-thirds of this amount are avoidable (Beretta et al., 2013; Engström & Carlsson-Kanyama, 2004). Hafner et al. (2012) attribute the Food Service industry as the second highest source of Food Wastage after households along the value-added chain in Germany (Hafner et al., 2012). Engström & Carlsson-Kanyama (2004) went further measuring food waste at the different stages of the food service process, obtaining that 4% to 10% of the amount delivered was wasted on handling of the food, storage, preparation and serving, and more relevantly plate waste accounted for 11% to 13% of the amount delivered.

Different categorizations make quantifying food waste difficult (Buzby & Hyman, 2012), and on top of that, comparing research results is difficult as we verify in the literature that each researcher uses his own classifications and measurement processes. For instance, FAO figures have been considered unreliable (Bender, 1994; Smil, 2001) although Lipinski et al.(2013) think they are the most comprehensive global numbers available. Canali et al. (2014) quantification on food waste is estimated with data only obtained for up to a quarter of the EU28 members (where data from Spain appears as “nonavailable”).

This said, researches measuring food waste at the food service industry show striking data such as a range between 19% to 66% food waste in Welsh hospitals under study (Sonnino & McWilliam, 2011). Nevertheless, scholars agree on the necessity to perform more solid quantifications and in more countries (e.g. Betz et al., 2015; Engström & Carlsson-Kanyama, 2004).

2.2.3. Food waste drivers

Comprehending food waste drivers in an integrated perspective through the food supply chain is essential to find solutions and consequently prioritize initiatives for action (Canali et al., 2014; Paola Garrone et al., 2014; HLPE, 2014). Canali et al. (2014) suggest a classification based on 7 groups, from Production to Food Service and Household. At this point, researchers agree that food waste is produced by diverse reasons (Canali et al., 2014) and at different stages of the process (Gustavsson & Stage, 2011). In fact, every process in the food Supply Chain –production, transport, storage, cooking- is embraced in the waste produced (Sonnino & McWilliam, 2011).

Accurately predicting demand is highlighted as a significant factor that may contribute to food waste generation while rigid food procurement specifications is also mentioned as a cause of

food waste as when products - notably fruit & vegetables - do not fit in with standards they cannot be put to its intended use (Göbel et al., 2015). In fact, Göbel et al. (2015) reveal different main reasons for waste depending on the food categories: quality standards for vegetables, freshness for bread & bakery, production process for milk & diary and health and cost pressure for meat products. They finally summarize seven central potential causes to food waste, namely: Quality standards, Legal requirements, Market conventions, Human errors, Technical issues, Logistic issues and Cultural influences. They strongly emphasize the inter-dependency between the different stages stating that demands on products in a specific stage can create waste in stages that differ from the one in which these are made (Göbel et al., 2015).

At the final stages of the food supply chain the lack of concepts for subsequent use and insufficiently utilized ways of disposal are also linked to the generation of food waste (Göbel et al., 2015). Nevertheless, Bernstad Saraiva Schott and Cánovas (2015) consider that waste varies significantly depending on the type of food served (Pirani & Arafat, 2015). Thus, vegetables, fruit, bread, cheese & other dairy products, fish and meat should be differentiated when studying drivers for food waste. Product natural characteristics such as shelf life, demand fluctuation, and storage requirements have a significant influence on the level of waste (Mena et al., 2011).

At the food service sector, significantly, side dishes and accompaniments are often left by diners in restaurants; for this reason, vegetables and starch are top food waste categories (Betz et al., 2015) seemingly because they are low-cost items (Charlebois, Creedy, & von Massow, 2015). Furthermore, Wansink (2013) did research on the influence of dinnerware size on self-serving food waste concluding that diners with large plates wasted a lot more food than those with smaller plates. Related to the influence to dinnerware on food waste, Kim & Morawski (2012) suggested that the removal of trays in universities resulted in reduced food waste. Excess quantity was found by Collison & Colwill (1987) more relevant than poor quality as a cause of food waste when dining in restaurants, and that women and younger customers were more likely to leave food uneaten. Women are more likely to produce plate waste than men (Betz et al., 2015) and portion size is also significant, because when women serve their selves, food waste is significantly lower than when quantity served is determined by staff.

In order to give light to the complexity of food waste drivers, FAO in its HLPE report (2014) classifies causes of FW into three groups: 1) causes which result from actions - or inactions - of individual actors at a specific stage of de FSC; 2) causes which can result from the way different actors in the FSC are organized together or relationships along the food supply chain, i.e. lack of communication, coordination and organization between food chain actors; and 3) causes which respond to more systemic causes, those ones that favour the emergence of all the other causes, such as the absence of an enabling environment to support coordination between actors.

Nonetheless, the lack of awareness on food waste is one of the reasons for the slow progress in reducing food waste as few people understand the scope of the problem (Finn, 2014).

To conclude, we find interesting the analysis proposed by FUSIONS (Canali et al., 2014, p. 5), in which among the causes of food waste in the Food Service channel, our research object, they mention five which are related to technology, storage, equipment & containers and lack of good practice, opposed to business related drivers such as the difficulty to estimate and calculate the right amount of food to cook, consumer expectations prediction & demand forecasting, inflexibility in portioning, food being prepared but not served, food being served but not eaten, contracts imposing caterers too wide assortments, prioritize turnover and consumer satisfaction, and variety in choices offered (Canali et al., 2014, p. 23).

2.2.4. Tackling the food waste issue

Finn (2014) argues that an urgent switch is needed to reduce food waste globally on the grounds that we cannot afford to waste 30 to 50% of our food nor can we afford the environmental consequences of it. He supports that institutions, corporations and consumers must unite efforts on behalf of their

responsibility to feed nine billion people by 2050. Furthermore, research should not merely observe and explain the empirical phenomena but aim to help change the status quo (Seuring & Gold, 2013). Waste at the distribution and consumption stages is relevant because food has gone through all the previous value chain stages, accumulating costs and resource use. Nevertheless, it is a very difficult issue to address for managers, as its costs most of the times remain "hidden" (Mena et al., 2011) and they are often undervalued an underreported (Binyon, 2007). With the objective to uncover this hidden cost, researchers like Lipinsiki (2013) highly recommend the development of a food loss and waste measurement protocol, linked to setting reduction targets and the support to collaborative initiatives to reduce FW(Lipinski et al., 2013). Other best practices for the Food Service sector suggested by researchers include increasing awareness of the importance of reducing FW among food service customers together with temperature control issues and speed in reception of deliveries together with FIFO storage system (Engström & Carlsson-Kanyama, 2004). Furthermore, Betz (2015) underlines the optimization of storage management, stock minimizing, training of employees, fast cooling down of food to avoid microorganisms growth, adaption of portion sizes to customer needs, attractive presentation of meals, use of small serving bowls at the buffet, as well as sensitization of customers about FW and the use of feedback sheets among the recommended initiatives to reduce FW (Betz et al., 2015). Moreover, Falasconi et al. (2015) mention the importance of increasing flexibility in rations of different food types, menu planning and information campaigns aiming to increase dietary habits among students in order to reduce food waste in school catering. Finally, we must not forget the role of technology improvement and innovation on long-term approaches to reduce food waste (Beretta et al., 2013; Östergren et al., 2014).

Thyberg & Tonjes (2016) group food waste prevention under three key areas: Values: providing people with knowledge on FW so that they want to change their behaviour; Skills: increase abilities to be able to reduce it. (e.g. training); and Logistics, including better forecasting practices or improved packaging storage facilities and donations. He suggests holistic approaches across the food system are ideal solutions.

Due to the fact that food waste is produced at all stages of the food supply chain, solutions to the reduction should include multi-stakeholder collaboration (Halloran et al., 2014), taking into account that initiatives to reduce food waste in one stage could negatively affect another stage (Engström & Carlsson-Kanyama, 2004). Such complexity in the relations among different stages of the food supply chain puts forward the need to mobilize all actors around a shared vision for sustainable development (Sonnino & McWilliam, 2011) and the relevance of innovation through cross-sectorial approaches (Mathijs, 2012). Nevertheless, as Pirani & Arafat (2015) state, putting up a collaboration culture among supply chain members and even between food service staff and the guests could lead to FW reduction. Also interesting Garrone et al `s (P Garrone & Melacini, 2012) reflection of the fact that companies should work on their processes to reduce FW while legislators, companies, and food banks should collaborate to find innovative solutions to tackle with food waste (P Garrone & Melacini, 2012).

Göbel et al. (2015) recommend an optimization of value-added chains, focused on waste avoidance. They also defend the need to develop a new appreciation for food among people who act along the whole FSC through informing and educating actors and consumers on the topic of food waste. In this sense, (Strasser, 2014) interestingly underlines that this is of special relevance in the food service sector as we tend to undervalue food that is not prepared by ourselves or by our loved ones.

The legislation is also relevant on inducing corporate responsiveness and could lead to reducing food waste. On the other hand, stakeholders can also encourage corporations to consider sustainability impacts in decision making. Economic opportunities also drive firms` sustainability initiatives (Bansal & Roth, 2000).

2.2.5 Research gaps & Spanish research on food waste

Food waste research results are often based on rough estimates and are likely to have a high degree of error (Mena et al., 2011). If we take the current publications about food waste, scholars mention multiple research gaps in food waste and suggest that more research should be conducted on the amount of food wasted at every level of the food supply chain (Halloran et al., 2014), and about its social and environmental implications (Sonnino & McWilliam, 2011). On top of that, Tielens (2014) mentions the need for research on the impact of food waste reduction on food prices and he seizes the need of research to improve the effectiveness of value chains or food systems including food waste analysis as a part of it (Tielens & Candel, 2014). Finally, there are also several gaps on distribution management (Charlebois et al., 2015), and Food Service institutions, as research showed that levels of food waste were significant, recommending further research to better quantify losses, devise prevention and identify policy implications (Engström & Carlsson-Kanyama, 2004).

Otherwise, as there are different attitudes and insights with respect to food waste in different countries (Mena et al., 2011) as well as socio-cultural differences (Papargyropoulou et al., 2014), wastage patterns differ from region to region and country to country, further research is needed to analyse food waste in different geographical areas (Thyberg & Tonjes, 2016).

For Spain, object of this research, data on food waste in the Food Service sector are lacking. Although the Spanish Administration is promoting the campaign: "More food, less waste" to which our research belongs, aiming to engage society and all food supply chain stakeholders (Estudios Consultas & González Vaqué, 2015) very few researches have been found based in Spain in the literature review (e.g. SCOPUS, PROQUEST, DIALNET, and Google Scholar), and most of them related to recycling or with students eating habits (e.g. "Evaluando la aceptación de alimentos en escolares; registro visual cualitativo frente a análisis de residuos de alimentos). Two studies about food waste in Spain are interesting though: qualitative research by Mena et al. (2011), and González Vaqué (2015) who analyzes different initiatives performed in Spain to reduce waste highlighting the lack of legal initiatives. Mena et al. (2011) results, although focused only in supplier-retailer interface show that food waste drivers in Spain are, among others, bread short shelf life, the wide range of products in stock, defective products, damaged products during logistics, as well as bad temperature control. In his study, he suggests best practices and finally recommends further research on the topic, widening the scope and range of products under research.

In order to contribute towards filling this gap, we planned a research in the Food Service channel in Spain. The aim of this study is to shed light on the opportunities for food service businesses in reducing the amount of food wasted in the food Supply Chain. According to the previous review and development, a main research question shows up: Which business practices could lead to reducing food waste in the food service channel in Spain?

In order to answer this research question, we defined the following objectives:

1) To identify what is considered as food waste by Spanish Food Service companies.
2) To explore how to quantify food waste in Spain.
3) To classify and prioritize top Spanish food waste categories.
4) To explain the causes which lead to food waste throughout the Spanish Food Supply Chain
5) To explore Spanish management initiatives that can lead to food waste reduction.
6) To assess the multi-stakeholder collaboration as a necessary condition to reduce food waste.

2.3 Methods

The study of the business practices which could lead to reducing food waste in the food service channel in Spain includes a set of complexes social phenomena. To analyse this complexity, we designed a research with an explorative/inductive approach through primarily qualitative data (Pratt, 2009). The research had two parts: the first one includes the most research objectives of the study; the aim of the second part was to quantify how much is wasted by product category and where waste occurs in the process.

The method of data collection of the first part of the study was semi-structured individual interviews from different companies. The sample selection followed a strategy of quotas according to the type of the company (non-commercial food service, commercial food service, not for profit international organization, and others such as bakery industries). Due to the nature of the research, all companies should have satisfied the following criteria: at least a revenue in Spain of 10 M € in the last year, a significant market share in the areas where they compete. To identify these companies, we explored their web sites and existing reports. Moreover, this search helped us to obtain a great amount of information about their activities, the services they provide, and the profile of the companies they serve. The final sample consists of 14 companies (see more detail in Appendix A). More specifically, the final sample is formed by 9 food service companies, market leaders in their sector. We also selected two food production corporations, both in the bakery sector, and a fresh food wholesaler that distributes mainly fruits, vegetables, meat and fish to the food service channel. Additionally two institutions were included, due to their relevance in the topic: a not for profit organization was included because they are informed by privileged access to many suppliers and retailers at the same time and they assess their associate companies on food waste; finally, a food bank was included as their mission is closely related to food waste reduction.

The interviewees were representatives of the companies from management level. In addition to the interviews, in most companies, the statements were supported by company tours and informal interviews with employees. Due to the complexity of an analysis of this kind of processes, we developed a protocol as a conceptual and practical guide on data collection during interviews. The protocol is based primarily on the works of Canali et al (2014) about the reasons of food waste and their classification based on 7 groups, on the FAO (HLPE, 2014) with classification into 3 groups of causes of food waste, on Göbel et al. (2015) regarding the classification of food and its causes; on Gustavsson & Stage (2011) with different stages where food waste appears in the process, and finally on Thyberg (2016) regarding the prevention of food waste according to three key areas (values, skills and logistics). The protocol proposes a semi-structured interview design with open questions and unlimited time in order to capture possible unexpected results and redirect the interview according to the responses of interviewee. The protocol includes The interviews lasted an average of 60 minutes and all of them were conducted in places suggested by the interviewees to maintain their comfort and privacy. In addition, the interviews were recorded using an audio recorder. The protocol also suggests the annotation of interviewees' reactions (e.g., behaviours or nonverbal communication) when they are responding to questions. The transcript of the interviews was conducted by means of the Transcriber software following a process of double review.

The next step was the codification of the interviews through the methodological proposals of Bogdan & Biklen (Bogdan & Biklen, 1997) with the qualitative data analysis software called MaxQDA. The first step of interviews coding was to identify the blocks or paragraphs where the interviewees spoke about one of the elements suggested by Bogdan & Biklen (1992), such as Setting, Definition, Process, and Method. This first coding allowed defining the starting point from which we analysed the structure of each interview. The second step of coding consisted in assigning to paragraphs (or a part of them) a list of preconceived codes from the theoretical framework of the research. The initial list of codes contained 11 codes (Terminology, Demand and Planning, Procurement, Menu planning, Storage, Cooking, Service, Measuring & Control, Awareness, Collaboration and Type of Food). The third and final step consisted in coding the paragraphs with a

more inductive approach (encoding in-vivo), recoding some of the interviews as new codes emerged. The final code book contains a total of 56 codes that classify data into the following blocks: Concepts (e.g., food waste), Stage of the process (e.g., cooking), Type of food (e.g., bakery), Management (e.g., sales forecast), Food waste drivers (e.g. shelf life), Collaborations (e.g., Food Banks), and Control and Measurement (e.g., Quantification).

After the encoding process in the 14 interviews transcribed, we analysed each interview and later we analysed them all in block following the suggestions of Miles and Huberman (Miles & Huberman, 1994) and Jurgenson (Jurgenson, 2005) with the goal of obtaining a specific vision of each case and a final conclusion for all cases. The first step of this part of the analysis was to build a checklist matrix to coherently organize several components for every case. These matrices showed the different sources of data (interviews) in rows and the topics or codes (both the codes from the second and the third step of the coding process) in columns. The matrices allowed us to display the interviews of the codified elements and their reliability and importance according to the number of sources that corroborated them. Moreover, we identified some gaps in the interviews, as well as some inconsistences. With the goal to achieve a complete view of each case, we decided to interview more managers of some cases. More specifically, we needed more individual interviews with two other managers in case A1.1 (see more detail in Appendix A) and one more manager in case C8. This extra information allowed us to conduct triangulation according to source which is useful for improving the validity and credibility of information (Doherty, 2009).

From each case, we generated a Role-Ordered Matrix that showed the several processes throughout the study period. Based on the matrices, we re-analysed the strategies and initiatives of food waste that we had previously identified in Spanish companies. As a result of the former analysis, the causes and the strategies in each part of the supply chain are identified (see results for more information). After the analysis of each case, we carried out a Cross-Case Analysis in order to enhance generalizability and to deepen understanding and explanation of the food waste in Spain. Following a code-oriented strategy, we developed a Case-Ordered Effects Matrix (based on Miles and Huberman, 1994), which placed the strategies in each stage of the supply chain we had identified before in the rows and the consequences and the rest of the coded data related to these processes (participants, settings, relationships, etc.) in the columns. Clustering the strategies and initiatives according to similar or equivalent consequences, we analysed the rest of the data from these processes (e.g. stages of the food supply chain, types of companies, types of food, quantification) in order to identify shared elements. To achieve this goal, the analysis was performed by means of successive attempts of trial and error from the data gathered.

As we have mentioned, the research consisted of two parts. From the results of the first part, we tried to quantify food waste by product category in Spanish companies. The method of data collection of the second part of the study was the survey from different companies. The sample selection followed a strategy similar to that in the first part of the study. The final sample includes 20 firms (10 from the first part of the study and 10 additional firms to which we had posterior access). We elaborated a questionnaire with semi-open questions in order to gather terminology and definitions used and closed questions aiming to quantify how much is wasted by product category and where in the process wastage occurs. The questionnaire was divided into four parts, related to the above mentioned codes. Part 1 was about terminology & classifications; part 2 about quantification; part 3 about food waste causes, and part 4 about current initiatives implemented to reduce food waste. The quantitative results obtained allowed us to get an estimation of the amount of food wasted as the questionnaire included a table to be filled by the companies with kilos wasted as well as % on overall kilos consumed according to food category and production stage. These questionnaires allowed us to additionally interpret and complete qualitative results formerly obtained.

2.4 Results & Discussion

2.4.1 Definition & typologies of food waste

The results of our research confirm that there is neither a clear nor homogeneous definition of food waste across the organizations interviewed: *"There is great confusion nowadays about the terminology related to* food waste*"* (A8.1); *"Food waste is simply food that cannot be commercialised anymore"* (M1).

In fact, a great number of terms were used to address food waste, many of which even had different meanings in different organizations or even among different persons in the same organization. We listed up to 20 different terms; some of which could be translated as waste, wastage, loss, leftover, residue, rubbish, organic, rubbish, production loss, shrinkage, stale, leftovers, breakage, spoilt… Therefore, the lack of common terminology when speaking about food waste across the sector is an important research limitation.

We concluded from our exploratory research that food waste definitions can be classified in three different ways (summarized in table 2.2): 1) attending to when and where waste is generated; 2) attending to its grade of avoidance, and 3) from a business perspective and relative to who produces the waste and on how relevant it is perceived by business managers. This latter definition was not found in the literature and noted by A1.1.

First, we can classify food waste attending to when and where it is produced, akin to Engström (2004) & Betz (2015), although as described in table 2.2, our definition emphasizes the place (kitchen vs service) and moment when waste is produced, in order to ease correction initiatives: *"We are focused on production losses. What is sold is not our responsibility any more"* (D3); *"There are three types of losses: out of date products, production losses and service losses"* (A6).

A second classification of waste identified in our research, similar to Papargyropoulou et al. (2014) is to distinguish between avoidable waste, that is, food that might not have ended up as waste with better management, partially avoidable waste, which is food that is finally diverted to uses other than human nutrition, and finally, unavoidable waste, such as peels, bones, etc.: *"Fresh products all have losses, commonly because of their natural shelf life or for economic reasons. For example, 30% of the bananas sold in supermarkets end up thrown away. But this is life, you cannot change it"* (M1); "*We usually throw away stale bread. We could sell it as animal feed, but then you need to take the packaging away and this costs more than what you can get from it" (*D2).

Under this context, we concluded from our research that it would be easier to reach a consensus on the terminology if we classified waste based on where it ends. Firstly waste that finally has a final utility would be included under the concept of avoided waste and would include for example donations, recycled food or food sent to secondary markets. This concept would include food that although not having received the use for which it was produced, does not end up discarded. Opposed to this concept would be real food waste, meaning food that ends in landfills, compost, etc. This classification could well have reduced the reluctance of corporations to answer our questionnaire, as some of them felt that giving waste figures meant they recognized not being efficient and therefore the reason why we had such a low response rate (100% complete) to our questionnaire.

Finally, from a strictly business / management view our research suggests a new additional way of classifying food waste, not found in previous literature. Based on who gives origin to the waste and on how relevant this is perceived to be by business managers, it seems critical to distinguish two additional food waste categories:

1) **Pre-consumer waste** (or waste produced before food is served on diners' plates or trays) is considered by food service companies as directly related to their profitability and consequently, managers tend to naturally minimise it. Whenever no effort is made by operators to minimize this is due to its low visibility or to marketing reasons. Pre-

consumer waste would include damaged and out of date ingredients, kitchen waste, plates displayed but not sold, etc.

2) **Post-consumer waste** (or food left uneaten by diners) is not considered an economic burden for the business. We give this term a slightly different meaning to Parfitt et al. (2010) who use it to address household waste. From our standpoint it would include plate waste and food surplus caused by the need to accomplish contract obligations (e.g. when catering companies must offer a specific number of alternatives to diners in a buffet until the end of the service or a specific portion size for example of bread). Most managers interviewed consider post-consumer waste a decision of the consumer or client, opposed to a business indicator to be managed: *"Plate leftovers are the consumers` responsibility" (A2); "I do not measure what consumers leave on their plates, I only measure my own inefficiencies" (A7); "You cannot consider what consumers decide to leave uneaten as waste" (A4); "We are very good at cost control and therefore we produce very little waste" (A6).*

Summarising the three abovementioned classifications resulting from our research (table 2.2) we can conclude that causes of food waste and adequate solutions to reduce it must be understood under this perspective of when and where in the process food waste has been produced (Classification I), where food waste ends up (Classification II) combined with how relevant it is to business managers (Classification III). In the next section we shall analyse in detail food waste causes and will suggest best practices in order to minimize waste in each step of the process.

Table 2.2 Typologies of food waste found in Spanish food service & its relationships

<table>
<tr><th colspan="2">I
Attending to where waste is generated and produced</th><th colspan="2">II
Attending to where it ends</th><th>III
Attending to who originates it/how relevant is for the company</th></tr>
<tr><td rowspan="4">Kitchen</td><td rowspan="3">Damaged & out of date ingredients</td><td>Animal feed</td><td rowspan="2">Avoided Waste</td><td rowspan="5">Pre-Consumer Waste</td></tr>
<tr><td>Industry derivatives</td></tr>
<tr><td rowspan="2">Bones, Skins, Shells, peels….</td><td>Unavoidable</td></tr>
<tr><td>Kitchen Waste</td></tr>
<tr><td rowspan="3">Service</td><td>Cooked but not served</td><td rowspan="2">Display excess, self-service, leftovers, etc. that go to Trash bin, dumpster, landfills, compost</td><td rowspan="2">Avoidable / Partially avoidable</td></tr>
<tr><td>Served but not eaten</td><td>Post-Consumer Waste</td></tr>
</table>

2.4.2 Is it possible to quantify & classify food waste in the Spanish food service channel?

Our research shows that not only the lack of consensus in food waste definition is a hindrance, but quantifying food wasted is abnormally difficult as its visibility is normally very low. Many businesses in the sector are not aware of the waste they produce. Low visibility of waste produced is, therefore, a key factor: *"We produce no waste. If we did, it would mean that we are managing inefficiently" (A4); "Efficiency implies close to zero losses or shrinkages" (A8); "Existing statistics are all wrong, most measures are not properly done" (M1).*

Through the results of our survey we estimate that 13,5% of the volume managed by the companies included in the sample is wasted in the food service sector. This figure includes plate leftovers although as said before it is very rarely measured by operators. Our survey showed the following estimated quantitative results per category (% on total kilos used or bought): Plant-based food: Bakery (15%), Fruits & vegetables (25%), Animal food, Dairy (6%), Meat (9%), and other (20%). Plate waste resulted to be 30% of the total kilos wasted. The biggest losses come from fruits and cooked dishes.

2.4.3 Drivers of food waste and practices for its reduction

Similar to Gunders` (2012), our research confirms that causes of waste vary depending on the stage of the channel and therefore, solutions to reduce it must be developed ad-hoc. Food waste causes and best practices suggested by our interviewees are grouped according to process stages.

In the procurement process mistakes in demand planning are responsible for an important part of food wasted in Spanish food service business as it is acknowledged as a difficult task, affected by many factors out of management control. Deep historical data analysis and the use of advanced demand planning software were mentioned as best practices. So-called "Kilometre Zero" procurement practices (local products) were also mentioned as possible food waste reduction drivers mainly because of the higher distribution flexibility usually offered by close-by suppliers: "*We only buy lettuce from local suppliers as they can deliver based on daily needs*" (A4).

Menu management was mentioned as another key issue: the wider the menu offered, the more difficult it becomes to minimise waste. Planning menus in a creative way, such as including that use ingredients that would otherwise be discarded for example for being leftovers of other plates on the menu. In the case of catering companies, smart menu planning means using ingredients left from one day in the menu of the following day. Respondents also mentioned the lack of adequate formats offered by suppliers (e.g. 5 kg cans of a specific sauce was the standard food service format meaning that it often expired before it could be used). Collaboration with suppliers with the objective to adapt formats to customer needs, as well as the use of packaged portions or frozen solutions, were suggested as best practices to address this issue. Another recommendation was to concentrate procurement responsibilities to one single person as this facilitates detecting errors due to the fact that one person can have a global view and will be able to optimize the whole process more easily.

In the storage stage**,** stock management and permanent control were mentioned as critical areas. The FIFO system should always be used, best before dates should systematically be revised, and technology-related issues such as the availability of vacuum packaging equipment to better preserve food leftovers. Expiry dates being controlled on a regular basis would reduce raw materials having to be discarded. At this point, it is important to recall the relevance of controlling both primary and secondary (once primary packaging has been opened) expiry dates. The use of so-called fourth or fifth range products (pre-prepared food) was also mentioned as a driver of low food waste.

With regard to transport, the most critical issue is considered to be supplier flexibility on distribution and the frequency of their delivery calls. This is critical for short shelf life products.

In the cooking process, training and consciousness of employees on waste is alleged to make a huge difference. Raising awareness of how much food is wasted daily was mentioned as a key issue. Business with a top-down focus on reducing waste include waste management in personnel meetings and even daily calculating avoidable waste and following its progression. On this point, it is mentioned as relevant to share the results of this measurement with employees and benchmarking with similar centers. Increasing the visibility of what is thrown away during the cooking process can be achieved for example by simple measures such as using transparent rubbish bags: *"After we started using transparent rubbish bags at sites, waste was reduced as managers increased their awareness of waste produced" (A9); "Training kitchen personnel is key, fundamental to help them organise what they prepare based on demand planning" (A4).*

At the service station, offering half portions and child menus was mentioned as a best practice to be considered. As side dishes, as well as bread, were top waste categories in post-consumer waste, offering them as optional is highly recommended. In the specific case of self-service restaurants (such as hotel buffets), reducing the range of products offered at the end of the service, while offering alternative dishes to diners was mentioned as a best practice too. Suggested sales by waiters is another tool that is frequently used by restaurants meaning that waiters get instructions to recommend specific dishes when there is risk of a high pre-consumer waste.

Raising awareness on food waste among consumers can also lead to waste reduction. One

interviewee (A1.1) mentioned that few consumers acknowledged they "*serve themselves to bread automatically*" without caring about finally eating it or not. This fact was of strong relevance in catering facilities with a self-service bar as in most cases bread was offered at the beginning of the line meaning that consumers grab it before they know what they are going to eat. Take away containers, though seldom offered in Spanish food service outlets, could help reduce importantly plate waste. Interviewed consumers mentioned that they felt shy to ask for such containers - "doggy bag" -, but when proactively offered by waiters, the rate of acceptance was very high: *"Since we decided that our waiters would offer all our customers the availability of take away containers, 85% of them used them, significantly reducing plate waste" (A5).*

Food service managers that regularly control plate waste can figure out dishes that generate too much waste or portion sizes that are too big and act in consequence resulting in improvements not only for food waste management but also for consumer satisfaction. *Nevertheless, as already stated,* Food Service operators in our research considered plate waste as the consumers´ decision and thus they do not measure it as they consider it has no effect on their financial results: it is "*already sold*" produce. In fact, only one firm in our sample occasionally measured plate waste. However, managers in companies that made efforts towards reducing plate waste mentioned they were motivated mainly by their managers orientation towards sustainability in general or mere marketing policies rather than by specifically reducing food waste.

2.4.4 Management initiatives to address food waste in Spanish food service channel

Without failing to recall the opportunities for food waste reduction described in the literature for this sector (e.g. Betz et al., 2015) our research findings suggest that Best Practices addressing food waste reduction in Spain (summarised in table2.3) can be categorised into three groups:

Improved Management Processes

In order to embrace sustainability, companies must change their management practices (Kotler, 2011), and this will be achieved by adopting the 3R "*Reduce, Reuse Recycle*" (Society, 2005) design mind-set in products and services. As described before, certain management related issues such as demand planning, improved purchasing models, best before dates control , adapting new technologies and pre-prepared food, among others, are key in food waste management.

We concluded from our research that implementing best practices is usually related to the interest of corporations´ in reducing food waste. Our study shows a relationship between such interest and economic issues, together with top management interest on sustainability issues. Whenever managers see the opportunity of improving their profitability they will apply measures & improve their processes. This does not always occur mainly due to two reasons: waste may not be visible to them and it may collide with marketing objectives. Business managers interviewed in our research agreed on the fact that fulfilling their business positioning objective (in terms of image) would always be prioritised on the reduction of food waste or other secondary objectives. Manager's understandable priority is to focus on their positioning strategy as it differentiates their offer from their competitors guaranteeing sustainable economic profits. Therefore, they are prioritising the economic pillar of sustainability over social and environmental issues: "*Our customers come for the size of our hamburgers, we are not going to change this" (*A4); "*We assume stale bread as a cost in our P&L, it accounts for over 6% of our revenue. Assuming this cost is needed in order to offer the freshest product in the market" (*D2); "*Merchandising is important: we need to have product on display until closure time. It is more expensive not to sell than to throw away some produce. Raw material cost is low while personnel is a fixed cost" (*A10).

Waste produced is thus only considered a low relevancy secondary issue. We can infer from this that improved management processes & economic drivers, although important in food waste management, cannot be the only solution to the problem.

Raising visibility and awareness about food waste among all stake holders

Binyon (2007) mentioned that one major problem associated with food waste is that its costs are often undervalued and underreported so they remain "hidden". Raising awareness of these "hidden" costs could be a catalyst for resolving the problem as businesses will realise the scale of the predicament and its impact; we propose raising awareness as the core of the second best practice for food waste reduction. Most importantly, increasing waste visibility usually results in waste reduction. Corporations which had implemented waste audits or other plans to emerge waste since reported important improvements. Such firms even reported surprise from operational managers and the fact that once waste was made evident, they naturally applied corrective measures. Simple initiatives such as the use of transparent plastic garbage bags proved to be effective. Regular waste audits are consequently highly recommended as we can infer that once managers are aware of the waste produced, they automatically apply measures to reduce it: "*We launched an initiative to reduce waste at the production stage and the key issue was to force people to recognise that they were throwing food away. What we did to deal with this is to create three-member teams in each production centre to measure waste daily*" (A1).

We propose in line with results obtained, that raising awareness must be implemented through communication, training and improved processes at different levels: a) diners, to reduce plate waste, b) food service companies on the importance of measuring food wasted, fixing reduction objectives and following-up on all this; c) employees, on kitchen and service best practices, and d) contractors, on the relevance of contract clauses on food waste. As acknowledged by one of our interviewees: "*We significantly reduced waste through a training programme for managers. We trained them on daily orders based on historical sales and weekly sales forecast"* (A9).

2.4.5 Collaboration among different players in the food supply chain

Food waste can also be reduced by multi-stakeholders collaboration. Practices suggested by our interviewees lead to the need for collaboration with logistic partners (in order to reduce safety stocks), collaboration with suppliers (in order to adapt formats to real kitchen needs), as well as the need for looking over customer-supplier contractual obligations having food waste in mind, and private-public cooperation aiming to reduce food waste through regulation and public contract conditions: *"We have significantly reduced waste by reducing safety stocks in trains and by increasing communication with suppliers" (A7); "Contractual obligations often produce waste in food buffets because you are usually obliged to offer the last person to enter the buffet the same dining alternatives as the first one" (A6).*

Collaboration with NGOs to increase donations was mentioned by most of the firms interviewed and they all agreed that Spanish legislation does not facilitate donations due to the fact that responsibilities are not limited to donors as occurs in the US or Italy. Finally, related to the public sector, there are tax-related policies as well as public contract requirements: *"In Spain we lack a law similar to the Good Samaritan Act. We can only donate packaged food which is a minority in our business. We have an agreement with an NGO which collects surplus packaged food in specific events" (A1.2); "I would suggest public contractors to require waste management policies to their suppliers" (A1.1); "Throwing away food is cheaper than donating for corporations is Spain" (M2).*

With this in mind, we must agree with Garnett (2008) that food supply chains should be considered to be a complex system of inter-related stages in which initiatives taken in one step are dependent on and part of the whole food supply chain. The synergies between these parts and stages deserve a much more careful consideration in our efforts to understand and enhance the sustainability of a food system (Garnett, 2008). Moreover, external stakeholders increasingly put pressure on companies requiring them to accomplish sustainability commitments exceeding regulatory requirements (Grimm et al., 2014), while in order to reach their sustainability standards

and commitments, corporations often need to force their upstream suppliers to adapt sustainable practices (Hassini et al., 2012). On the other hand, facilitating collaboration with NGOs can be a driver to increase non-economically driven sustainable initiatives in corporations. Collaboration among stakeholders is, therefore, mandatory to achieve a more sustainable food supply chain.

Table 2.3 Proposal of Best Practices to reduce food waste in Spanish food service sector

Group	Best Practice
Improved management processes	Demand planning using ICT
	Regular waste audits
Raising awareness about food waste and Training among all stake holders	Diners (to reduce plate waste)
	Food service companies on the importance of measuring food wasted, fixing reduction objectives and doing follow up.
	Employees
	Contractors
Collaboration among different players in the food supply chain	Collaboration with logistic partners in order to reduce safety stocks
	Collaboration with suppliers in order to adapt formats to the real kitchen needs
	Look over contractual obligations having FW in mind
	Collaboration with NGOs to increase donations

2.5 Conclusions

Our paper provides new contributions to the literature on food waste. Firstly, a new conceptualisation on food waste based on business reality. Secondly, our quantitative analysis shows that the problem is relevant in the Food Service channel in Spain, and finally we identify specific best practices for Spain.

Each country and each company are at different levels of awareness about the issue as well as about practices to face it. We agree with food waste researchers (e.g. Aschemann-Witzel, de Hooge, Amani, Bech-Larsen, & Oostindjer, 2015; e.g. Göbel et al., 2015) on the fact that further in-depth research is needed and it should focus on exploring and understanding particular food waste context and interactions. As acknowledged by EU research, FUSION (2014) due to the complexity of the food supply chain, there is no way of applying easy solutions to all circumstances.

As for contributions to food service management for food waste reduction our research confirms that Spain is, among developed countries, at an intermediate stage regarding food waste management, and far from approaches in countries such as the UK, Germany or Denmark as shown by the fact that there is not even a common language when speaking about food waste across the sector. With regard to measures carried out by different Spanish players to reduce food waste, results show that these are closely related to their interest in minimizing it. Only by looking for opportunities that make food waste management "profitable" for firms will waste be reduced. In those cases in which initiatives to reduce food waste would not be profitable in economic terms, they will most probably not be put into force. Consequently, due to the fact that the main motivation for Food Service companies in Spain is economically based, we can conclude that the higher the cost of food waste is for firms, the higher their interest will be in reducing it. Whenever measures are not taken it is usually due either to (1) its low visibility or low real awareness of waste, (2) marketing issues also related with economic results - expected sales decrease when reducing waste - or (3) because waste is produced once food has been sold (*post-consumer waste*). These conclusions are aligned with Canali et al. (2014) who argued that changes are potentially more feasible when depending on improvements in manufacturing or production efficiency along the food supply chain.

This research shows that Spanish corporations give a medium relevance to social consequences of food waste. They usually acknowledge the ethic perspective of food waste although this is rarely translated into initiatives or programmes due to economic or legal issues. Finally, with

regard to the environmental perspective of food waste, their concern can be graded as low due to the low awareness or credibility of the negative consequences of food waste for the environment.

The application of best practices mentioned in this paper can help reduce food waste in the food service channel in spain, and they can also mean a starting point for reflection and study for researchers and corporations in other countries. As underlined by Seuring (2013), researchers should not limit theselves to observe and explain the empirical phenomena but aim to help change the status quo. EU administration should try to achieve a unique definition and communicate it to all stakeholders. Spanish Administration should address a double fold strategy, as suggested by EU Fusion, firstly to "measure food waste robustly at all sector levels" (Canali et al., 2014, p. 3), and secondly, *"to create a framework to enable society to undertake the necessary engagement to prevent and reduce a largely avoidable wastage of resources"* (Canali et al., 2014, p. 6).

As with most research in food waste, this study could be improved by performing direct measurement of wasted food. We have to take into account that the conclusions comes from a sample which includes commercial and collective food service operators, which account for 25% of the out of home market in Spain, but does not include independent bars & restaurants.

CHAPTER 3

TRACKING FOOD WASTE AT SCHOOL CANTEENS. A FOOD WASTE SELF-EVALUATION TOOL DESIGN

The global food system still has to solve deep problems in order to be truly sustainable. One of the key sustainability challenges brought up by researchers (Clarke, Schweitzer, & Roto, 2015; Finn, 2014; Garrone, Melacini, & Perego, 2014) in the last few years is waste. In particular, reducing food waste would aid in the path towards a more sustainable global food system as it would imply a more efficient (and ethical) use of scarce natural resources at the same time as helping reduce its significant environmental footprint (Buzby & Guthrie, 2002). This is particularly challenging in developed countries, as food waste is very closely related to individual behaviour and cultural attitudes towards food (Godfray, Crute, et al., 2010).

3.1 Introduction

Business managers are at present considered the major actors trying to implement sustainable development, opposed to some years ago, when focus was put on local authorities (Dyllick et al., 2002). In fact, many companies and institutions, particularly schools (Rickinson, Hall, & Reid, 2016), have initiated a full set of sustainable development initiatives to address the demands of public and private stakeholders. With regard to food waste, progress has been slow, mostly due to lack of awareness (Finn, 2014). Hence, increasing visibility and awareness on food waste through audits is an obvious place to start. Once food waste has come to light, people will probably be willing to act against it, managers will probably become more concerned about its financial impact and kitchen staff about its social implications (Goonan, Mirosa, & Spence, 2014). In any case, food waste auditing should be the starting point of a food waste awareness campaign.

As schools are a natural place for education, and making the most of the near universal attendance of school by children and the fact that they are on the premises for many hours a day (Dehghan et al., 2005), addressing food waste at school canteens becomes noteworthy. However, regulators, school managers, and catering companies very rarely concentrate on reducing food waste. Instead, they usually focus on analysing how effective nutritional programmes are (Wilkie,

2015). For this reason, most researchers have limited their studies on food waste at schools to the analysis of plate waste, concerned with the nutritional value of effective dietary intake. Our research has a broader purpose, offering a more holistic approach on school food waste. Standard criteria for measuring school catering food waste is novel in the literature, particularly as we propose to include both pre-consumer and post-consumer waste in our assessment tool, while most researchers in this area have focused their work on analysing plate waste (Adams, Pelletier, Zive, & Sallis, 2005; Byker, Farris, Marcenelle, Davis, & Serrano, 2014; Cohen, Richardson, Austin, Economos, & Rimm, 2013; Marlette, Templeton, & Panemangalore, 2005; Rodriguez Tadeo et al., 2014). Moreover, through a standardised tool, researchers will be able to compare results and data from different studies. The goal of this research is to provide schools and educators as well as catering companies with a set of principles and tools that unveil and quantify food waste at school canteens and therefore facilitate the implementation of reduction measures and result tracking. With this purpose, we first analyse the nature and types of food wasted at schools as well as cafeteria managers´ attitudes toward food waste and end with the development of a self-assessment waste tool. This research has a very precise managerial implication. As a final outcome, a simple and easy to implement auditing tool has been developed. Through it, we aim to help managers and pupils in their efforts to increase the sustainability of the food system. The study is particularly relevant for schools with in-house kitchens, no matter if the service is outsourced - managed by a food service catering company - or not. Nevertheless, the tool could be applied to other business models too, with little modification. The scope of this research includes school canteens in both public and private schools. To achieve the goals of this research, we collected primary data from public and private schools in Spain.

3.2 Literature Review

3.2.1 The opportunity of addressing food waste in institutional feeding systems.

Food waste can be defined as all the products that are discarded from the food chain while still preserving their nutritional value and complying with safety standards (Falasconi et al., 2015). Estimates on the amount of food wasted globally are striking: FAO estimates that up to one third of global food produce is wasted, a fact that places food waste as one of the top challenges for global sustainability (FAO - Food and Agriculture Organisation of the United Nations, 2011). In Europe, despite acknowledging that food waste is a data-poor area across the main sectors in which it arises, the European Commission has quantified current average annual food waste at 200 kilos per capita, stating that this figure will increase significantly in the next years if no action is taken. They therefore recommend member estates to act, setting the objective of halving EU disposal of edible food by 2020 (European Union Committee, 2014).

On the other hand, researchers mention that a big impact may be achieved when addressing food waste at places where there are many individuals dining at the same place (Mirosa, Munro, Mangan-Walker, & Pearson, 2016). This is especially true in the institutional food service sector (schools, hospitals and prisons) where, as underlined by Mirosa et al. (2016), many individuals dine similarly, and therefore both efficiency along the supply chain and plate waste can be addressed. Moreover, Goonan et al. (2014) state that food service institutions are big producers of food waste, mostly during service, but also as a result of over production. In particular, researchers state that school canteens embody a significant source of food waste (Adams, Pelletier, Zive & Sallis, 2005; Smith & Cunningham-Sabo, 2014) and represent an ideal opportunity for minimising food waste foot print (Wilkie, 2015). Food waste was found by Wilkie (2015) to be the predominant component in a school canteen waste audit in three schools in Florida (US): between 58% and 69% of total waste weight was food, far more than paper, plastic & glass wastage. The mean daily food waste per pupil was averaged between 60.1 and 95.33 g. in schools with an in-house kitchen in this research. Therefore we can state that the institutional food service sector represents an ideal opportunity to

divert food waste from landfills thanks to their concentrated food waste stream due to the fact that they serve a high number of meals at a single location, resulting in food waste collected at only one location too (Wilkie, 2015). As a consequence, the institutional food service sector becomes crucial in the fight against food waste (Mirosa et al., 2016).

Food waste at school canteens could be reduced through educating pupils and staff in order to change behaviours that cause food waste (Wilkie, 2015). More concerned youths about food waste were found, by Principato et al. (2015), to be more likely to reduce leftovers. Furthermore, we can assume that these improved behaviours and habits will prevail into their adulthood (Guthrie & Buzby, 2002), a trend found by Mirosa et al. (2016, p.12) to be one of the key reasons for consumers not to waste food: "those who had grown up with the belief that they need to clean their plates" produced less plate waste. These more sustainable habits could be passed on further and have an effect on the amount of waste produced by future generations (Mirosa et al., 2016). There is evidence in the literature on the effectiveness of waste reduction initiatives. For instance, Ensgtröm (2004) carried out research aiming to measure the impact of a food waste reduction campaign in a school in Sweden resulting in a 35% reduction in plate waste compared to a baseline score. It is also acknowledged by researchers that people with a high knowledge of issues related to food waste are more likely to avoid waste (Principato et al., 2015).

Reducing food waste has obvious environmental and ethical benefits at the same time that it also has relevant economic implications as its associated costs are not only related to procurement of food ingredients, but also to disposal costs (Papargyropoulou et al., 2014). Moreover, both schools and families could save some money by reducing food waste. Pupils who eat more at school are less likely to spend money on substitutive products outside the canteen (Cohen et al., 2013).

3.2.2 Food waste auditing and reporting

Good sustainability performance is linked to a full and honest commitment of management to sustainability and to the adoption of incentives, something that should be done by setting appropriate goals, monitoring and evaluating progress (Székely & Knirsch, 2005). As stated by Gerbens (2003), measuring tools offering light on the sustainability performance of a firm turns out to be the very first move towards sustainability. More precisely, food waste inventories are claimed to be critical for the development of effective reduction initiatives and monitoring progress over time (Craig; Hanson, Lipinski, Robertson, Kai; Dias, & Gavilan, 2016). Conducting a waste audit in both the preparation and the display areas (kitchen and service line) as well as in the pupils' dining hall is the first step towards reducing food waste produced at schools (Bradley, 2011).

Framework

The World Resources Institute, WRI, (2016) together with partners such as Wrap, Unep and Fusions have developed a Global Food Loss and Waste Accounting and Reporting Standard aiming to provide guidance for governments and organisations to carry out inventories on food loss and waste. We have used this standard as a framework for waste auditing analysis.

As stated by the WRI, a Food Loss and Waste Inventory must be based on the five principles of relevance, completeness, consistency, transparency, and accuracy (World Resources Institute, 2016, p. 29). Relevance because it should contain the necessary information for the intended user to make decisions and because the quantification method should be selected based on the specific goals to achieve. Completeness because no relevant data or component should be excluded from the inventory, unless justified. WRI researchers go further adding that auditing methods should be consistent, allowing comparable measurements along-time in order to permit the identification of trends and the assessment on the performance of the audited institution. Transparency is gained by clearly reporting the quantification method. Finally, they acknowledge a trade-off between accuracy and completeness and cost and suggest choosing the optimal method based on the needs and

resources of the institutions.

Regardless of the objective and scope of the audit, entities should report on the following four elements (World Resources Institute, 2016):

1) Timeframe. Exact start and end date of the audit should be recorded. It is recommended to take seasonal variations into account when planning waste audits.
2) Boundary (organisation, geography, etc.) and particularities of the sample.
3) Scope (types of waste included). Records must include the type of food waste, the reason that caused it (e.g. overproduction, spoilage, trim waste …) as well as the estimate of loss (by weight or portions).
4) Waste destination (where waste goes after being discarded) must be accounted and reported because there are a wide range of possible destinations for food waste with very different associated environmental impacts.

The WRI Food Loss and Waste standard (World Resources Institute, 2016) establishes that methods, estimates and possible bias must be clearly documented and disclosed in a neutral manner. The auditing system should also register who recorded the data. Moreover, Bradley (2011) strongly recommends that the results of the audit are shared and discussed with the kitchen team and suggests that it could also be a great learning opportunity for pupils.

Due to their interest and particularities, in this section we shall further develop both the scope of the audit and waste destination.

Audit scope and categorisation

The scope of the audit must be clarified before beginning to measure food waste. Papargyropoulou et al. (2014) mention the relevance of distinguishing between avoidable and unavoidable food waste as a key factor in a food waste prevention strategy. Wrap's definition of avoidable food waste includes food discarded because it is unwanted or has been allowed to pass its best (Ventour, 2008), therefore avoidable food waste had previously been edible, although it might or might not be edible at the time of disposal. Papargyropoulou et al. (2014) explains that avoidable food waste includes foods or parts of food, usually considered edible, while unavoidable food waste is food that has never been edible, such as bones, fruit skins, etc. As described by Wrap, this includes waste from food that one would not expect people to eat (Wrap, 2011). Despite this classification being subjective, unveiling avoidable food waste reveals the substantial potential for food waste prevention (Papargyropoulou et al., 2014).

This leads us to the very first key characterisation when analysing food waste: whether it could possibly be avoided or not. Potentially avoidable waste might not have ended up as waste with better management while inedible food conforms to unavoidable waste. Whether to quantify both food and associated inedible parts removed from the food supply chain when performing a waste audit, the choice of studying only food, or only associated inedible parts, is to be decided depending on the purpose of the waste audit (World Resources Institute, 2016).

The vast majority of studies use some kind of further classification for the discarded food, usually related to the place or moment where waste is generated. Table 3.1 shows a few examples of classifications for avoidable and possibly avoidable waste used by researchers when analysing food waste.

Additionally, as noted by Papargyropoulou (2014), distinguishing between food waste and food surplus is a must when addressing food waste: food surplus is food produced beyond our nutritional needs while food waste is a consequence of food surplus. Proper meal planning will help caterers minimise food surplus and therefore the planning process should in some way be included in a waste audit.

Table 3.1. Characterisation of food waste by researchers, some examples

Author	(Derqui, Fayos, & Fernandez, 2016)	(Engström & Carlsson-Kanyama, 2004, p. 206)	(Ferreira, Martins, & Rocha, 2013, p. 1630)	(Falasconi et al., 2015)	(Clarke et al., 2015, p. 2)
Sector	Food Service	Food service institutions	University Catering	School Catering	Consumer (Households)
Boundary	Spain	Sweden	Portugal	Italy	USA
Characterisation of food waste	Pre-consumer weight	Storage losses	Weight of raw and cooked food not distributed ("leftovers")	"Avoidable" unserved food	Losses during cooking and preparation
		Preparation losses (mostly seeds, peel, etc. from fruits and vegetables)			
		Serving losses (left on plates, serving dishes and in canteen kitchens)		"Physiological" unserved food (cooked in excess to ensure some extra portions)	Food discarded due to preparation of too much food, expired use-by/open dates, or spoilage
		Leftovers (prepared food never served)			
	Post-consumer weight	Plate waste (what the diner leaves on the plate)	Plate waste (items returned at tray collection, after scraping off non-edible disposables such as bones, peels, etc.)	Food served but not consumed ("serving dish leftovers")	Plate waste or loss

With regard to plate waste, there is consensus in the literature on its definition (Mirosa et al., 2016). The term plate waste is used by researchers to refer to the amount of food served to pupils that is finally discarded. Its measures have been used with two main purposes: in order to decide how much food to prepare or order and, more importantly, to judge how well pupils accept the meals offered (Buzby & Guthrie, 2002) and assess their dietary intakes.

On top of the above mentioned classifications, most researchers measure food types in each of the previous categories separately. Depending on the purpose of the study, food type classifications can be broad, like the one used by Bykeret al. (2014) or Cohen et al. (2013) who classify food types into only four groups (main entree, fruit, vegetables and milk) or more detailed, like Marlette et al. (2005, p. 1), who mentions plate waste by the specific food item, such as applesauce, green peas, etc. using a more comprehensive classification with 10 food type groups: (a) mixed dishes (b) meats (c) grains (d) milk (e) cheese (f) vegetables (g) fruits (h) sweet snacks (i) savoury snacks and (j) beverages. Moreover, as mentioned before, other researchers use the nutrient content of food for their analysis instead of food types (Bergman, Buergel, Englund, & Femrite, 2004).

Waste destination

A waste audit would not be complete without recording waste destination. This is relevant as the environmental impact of food waste varies greatly depending on how it is discarded (Creedon, M., Cunningham, D., & Hogan, 2010; Papargyropoulou et al., 2014). Typical destinations of food waste can be landfills, animal feed, anaerobic digestion, biomaterial and compost, among others (Craig; Hanson et al., 2016). In fact, destinations differ significantly, from the most favourable to the least favourable environmental option in the waste management hierarchy (Papargyropoulou et al., 2014). Using the waste hierarchy as a framework, Papargyropoulou et al. suggest different options for dealing with food surplus and food waste where food surplus prevention is at the highest level of the pyramid. At the following step they suggest redistribution for human consumption, animal feed

and compost. Finally, at the lower levels, they list the worst environmental options, such as energy recovery (e.g. anaerobic digestion) and disposing of food waste in landfills - which they state should be used as the last option (Papargyropoulou et al., 2014). Currently, there are two primary approaches to diverting food waste from landfills: reduction and recycling (Wilkie, 2015). She goes further by stating that reduction can be achieved through education and awareness whereas recycling includes compost as well as conversion to fuel by anaerobic digestion or other related processes. Following the above-mentioned hierarchy, Birne (2010) states that from an environmental perspective, the best way would be of course not to produce food waste or to prevent food waste from over preparation, over trimming, etc. Secondly, he mentions reusing food for feeding people by reusing it in other meals, donating to the needy, or even diverting it to feed animals. Thirdly, he states that food waste should be recycled by composting or other processes. Finally, landfill disposal arises as the worst option for the environment and is at present regulated in many countries (Creedon, M., Cunningham, D., & Hogan, 2010).

3.2.3 Methods for measuring food waste

Most of the academic work on food waste in the food service sector has been conducted in schools or hospitals (Cohen et al., 2013; Williams & Walton, 2011) and is focused on plate waste (Adams et al., 2005; Buzby & Guthrie, 2002), being researchers concerned with the nutritive intake of children as well as with the efficiency of school nutrition programmes (Adams et al., 2005; Marlette et al., 2005; Smith & Cunningham-Sabo, 2014). Quantification methods in the literature are diverse. Comstock (1979) analysed and compared seven methods of measuring plate waste in the institutional food service, classifying them into two groups: direct and indirect measures of waste, depending on whether waste was actually weighed or estimated.

Direct (physical) measurement of plate waste is the most commonly used method by researchers, aiming to measure food intake at schools by the actual weighing of food discarded by children (Bergman et al., 2004; Cohen et al., 2013). Aggregate measures involve collecting all food waste and weighing the total bulk amount for a population (e.g. all meals from one sitting), while individual measures record either the total food remaining on each individual tray or the weights of each food component on each plate (P. Williams & Walton, 2011). Individual weighing is reported by researchers to be more accurate, despite its high logistical burden being a relevant disadvantage and it may make it difficult to implement without disrupting or delaying normal foodservice operations (Comstock, 1979; Jacko,Dellava,Ensle & Hoffman, 2007). Furthermore, when measuring waste individually there is a high risk of children changing their consumption patterns if being observed, thus biasing results (Guthrie & Buzby, 2002; Jacko,Dellava,Ensle & Hoffman, 2007).

Moreover, individual or aggregate measurements can be done selectively, that is, differentiating the weight of each food component, or non-selectively. Comstock (1979) criticised aggregate non-selective plate waste for not providing enough information and actually recommended aggregate selective plate waste defending that it was fast, accurate and easy to learn while at the same time providing adequate information. Going further on aggregate measures of plate waste, Jacko (2007) recommends the plate-waste method, which he describes as follows: first the mass of food being served is measured by weighing each item in the menu; then, after finishing eating, pupils are asked to discard individual food items into different labelled plastic tubes for waste (e.g. #1 beans, #2 bread, #3 meat, …) Then, total weight per item is recorded (net of the tub weight) obtaining the total amount of food waste. The difference between mass of each item served and wasted is the estimated food intake. Jacko (2007) concluded from his research that there were no statistically relevant differences between the estimations on energy and nutrient intake in children at school obtained using aggregate selective or individual physical measurements of plate waste.

Indirect measures include both visual estimation and dietary recall (named self-estimation of plate waste by Comstock (1979). Although Comstock (1979) considered visual estimation by

trained observers as being a non-obtrusive method but too time consuming and less accurate than weighing. More recent researches (Rodriguez Tadeo et al., 2014) have concluded that it can be a valuable method. Visual estimation is done based on different grading scales, Comstock's is the most commonly used, with 6 grades: full dish, almost full dish, ¾ dish, ½ dish, ¼ dish and empty dish (Rodriguez Tadeo et al., 2014). Despite Buzby (2002) mentioning that ratings can differ among observers as being a disadvantage of this method, Rodriguez Tadeo et al.'s (2014) research concluded that the visual scale was a reliable tool for measurement, although acknowledging the need for training catering staff as being inconvenient. Williamson (2004) performed research aiming to validate digital photography for measuring food portions (food served, food intake and plate waste) comparing it with direct visual estimations and weighed foods, concluding that both the direct visual estimation method and digital photography results were highly correlated with actual weighed food, and therefore, are valuable methods; although they acknowledge that both methods tended to slightly overestimate portion sizes compared to weighed food methods. Williamson (2004) supports the validity of both digital photography and direct visual estimation methods, based on the results of his research comparing results of both methods with actual weighing. He recommends digital photography for being less obtrusive and less disruptive in the eating environment.

On the other hand, when using the dietary recall method, children are asked about the type and amount of food eaten. Despite this method being easy to implement and low cost, results are highly biased by children's ability to recall (Jacko,Dellava,Ensle & Hoffman, 2007), as well as by the fact that children may want to please educators (Buzby & Guthrie, 2002). Comstock (1979) criticised both food preference questionnaires and self-estimation for not being reliable.

Table 3.2 summarises the pros and cons mentioned by researchers of the different measurement methods, based on Comstock's (1979) classification of methods in direct or indirect measures of waste.

Table 3.2 Methods for measuring food waste

	Method		Advantages	Disadvantages
Direct Measures of Waste	Individual Plate Waste		Accuracy Specific information provided (e.g. by sex, age, etc.)	High cost Time consuming Biased results
	Aggregate	Selective	Little disruption Easy to learn	No specific information provided by pupil
		Non-Selective	Fast and easy	Little information provided
	Rubbish Analysis		Non-obtrusive	Highly inaccurate Time consuming
Indirect Measures of Waste	Visual Estimation	Direct Visual	Non-obtrusive Non-disruptive	Time Consuming Subjective ratings Need for training
		Digital Photography		
	Food preference		Easy to implement Low cost	Low accuracy Biased results
	Dietary Recall			

Actually, the most accurate method for measuring food intake has been reported to be weighing foods before and after eating although it is reported to be time consuming, costly and disruptive (Williamson et al., 2004). This said, it is interesting to recall Smith's (2014) research in which, in order to confirm observer reliability he weighed 20% of pupil trays after consumption and compared the result with visually estimated plate waste using digital photography, resulting in a 92% agreement. This is consistent with the Environmental Protection Agency - EPA (2014), which suggests that when there are space and time limitations, visual assessment may be more appropriate.

Jacko et al. (2007) in their research suggest that an accurate measure of plate waste at schools should be done without direct contact with the children because this could influence their behaviour and bias results. They therefore recommend the use of aggregated methods. Moreover, they compare aggregate vs individual methods to measure plate waste, finding no relevant statistical differences. They conclude that aggregated selective plate waste measurements provide accurate results for

groups of children without the complexity of implementing actual weighed food measurements (Jacko,Dellava,Ensle & Hoffman, 2007). However, individual plate waste data would provide more specific information such as correlations between sex and age (Jacko,Dellava,Ensle & Hoffman, 2007). Therefore, even when using an aggregate method it might be useful to individually measure a small part of the sample. Furthermore, in order to generate useful comparators when using aggregate methods, total recorded kilos of waste are usually presented per pupil (Buzby & Guthrie, 2002).

3.2.4 Food waste research objectives and indicators in the literature

Before going deep into the particularities of our research scope, school canteens, as a baseline we used general recommendations from researchers on measuring food waste in general. Nevertheless, food waste studies in the food service sector have been performed mainly in the education and health sectors.

Generally speaking, before performing a food waste audit, an entity should clearly define why it wants to quantify food waste. The results may be used for internal decision making, reporting to the institution stakeholders or to develop a food waste reduction policy or initiatives (Craig; Hanson et al., 2016). The way in which results are presented is closely related to the purpose of the audit, where the most recurrent research objectives observed in our review of the literature are assessing novel nutritional policies and analysing the efficiency of the food system.

Food waste audit results are typically expressed by researchers through one or a combination of the following indicators:

1) Plate waste weight in grams per pupil (Ferreira et al., 2013; Wilkie, 2015), which can be calculated as the mean of individual measures or as a result of dividing total waste obtained in the audit when using an aggregate method by the number of diners. This output is useful when a comparison between different institutions is considered useful.
2) Plate waste index, calculated as a percentage by weight on served food that is discarded or eaten (Byker et al., 2014; Rodriguez Tadeo et al., 2014). This more explicit indicator is very often used for its conclusiveness and clarity. Ferreira (2013) highlights the fact that the plate waste index shows the interaction between the diner and the food, regardless of kitchen or system efficiency. We find in the literature researchers that present their results in either of two ways: as percentage wasted (Marlette et al., 2005) or as percentage consumed out of total amount served (Cohen et al., 2013).
3) Energy value of the waste, expressed as percentage of nutrients consumed against nutrients offered (Bergman et al., 2004). This indicator is used when the purpose of the study is assessing the dietary intake of pupils, without considering sustainability impacts of wasting food.
4) Total kilos wasted (Wrap, 2011). This indicator is normally used together with average grams per pupil with the purpose of increasing awareness on waste as big figures (kilos, tons) are more impressive than grams.
5) Monetary value of waste (Cohen et al., 2013) is very seldom used by researchers due to the fact that the research objectives are rarely related to cost. In order to determine the cost of plate waste, Buzby et al (2002) suggest multiplying the percentage waste estimate by the total budget allocation for food in the institution, although acknowledging this method does not adjust for differences in costs of food items wasted (e.g. bread vs meat or processed food).
6) Efficiency of the food service system (Falasconi et al., 2015), a ratio of the relation between processed food (kg) and unserved food (kg and %). As stated by Ferreira (2013), the "Leftovers Index" relates all food discarded in the food service process to the quantity of food consumed.

3.3 Research objective and methods

3.3.1 Objectives and scope of the study

We conclude from the literature that there is relevance in measuring food waste and the need to provide a standardised method that can ease its measurement as well as track its evolution along time. The development of a food waste measurement reduction protocol has been highly recommended by researchers like Lipinski et al. (2013) who go further by suggesting the need to link it to setting reduction targets and supporting collaborative initiatives to reduce food waste. Moreover, Wilkie (2015) states that before any food waste reduction or recycling initiative can be implemented, it is necessary to know the amount of food waste that is generated. With regard to plate waste, Jacko (2007) observes that more and more schools are acting to prevent child obesity, initiating changes in dietary education programmes and lunch menus; consequently, he states that it is vital to have an accurate and cost effective validated method to measure and track plate waste through which changes can be assessed.

Provided that food waste seems to be a challenge for schools in their path towards sustainability, and since as stated by Szekely (2005), there is a need to establish clear, user-friendly methods and tools to measure progress that companies are making toward sustainability (Székely & Knirsch, 2005, p. 1) the availability of a food waste self-auditing tool becomes valuable. A standard criteria for measuring school catering food waste is novel in the literature, particularly as we propose to include in our assessment tool both pre-consumer and post-consumer waste, while most researchers in this area have focused their work on analysing plate waste (e.g. Adams et al., 2005; Byker et al., 2014; Cohen et al., 2013; Marlette et al., 2005; Rodriguez Tadeo et al., 2014).

In order to contribute towards filling this gap, we conducted research in the catering food service sector at school canteens. The central objective of this study is to shed light on how initiatives and practices aiming to reduce food waste at schools can be measured and tracked. In order to attain this research goal, the following specific objectives were set for the research:

1) To analyse how research measures, assesses and reports food waste at schools.
2) To comprehend the level of awareness on food waste and its relevance for school and catering managers. To identify the elements that influence the generation of food waste at schools, understand its nature and the types of food being wasted as well as at which point waste is generated.
3) To develop a self-assessment auditing tool to be used by educational centres and researchers to measure and track food waste at school canteens.

Our practical perspective is also novel, a fact that gives our research a very useful and precise managerial implication. Our aim is to develop an easy to implement self-evaluation tool to be applied by school catering managers without the need of external assistance. Our auditing tool targets not only plate waste but also any losses before food is served with the purpose of assessing on the sustainability of the food service system.

3.3.2 Research on food waste at schools

With the purpose of doing an in-depth analysis of how research measures, assesses, and reports food waste at schools, our first research objective, we gathered over 20 studies by means of a Scopus search using as key search words - food waste and schools. Later, we found a few additional ones from bibliographies and citations. We analysed their objectives, methods, procedures and outputs

in order to understand their strengths and weaknesses and then used the knowledge to create the foundations for the development of a standardised auditing tool.

Studies performed in order to quantify the amount of food that is wasted daily at school dining facilities (Byker et al., 2014; Falasconi et al., 2015; Smith & Cunningham-Sabo, 2014; Wrap, 2011) show the effect of pupils' preferences and behaviour, and the effect of the food service regime on food waste from school meals (Wilkie, 2015). Although research objectives are diverse (see Table 3.3), the vast majority (80%) of studies focus on analysing plate waste. However, most of these studies are not complete food waste audits and do not account for food waste from kitchen preparation, or waste from serving lines nor food pupils bring from home. Despite being plate waste the most frequently reported measure in school food waste studies, it is not the only source of food waste at schools. Interestingly, Falasconi et al. (2015) undertook research in 6 schools in Italy and found a significant level of inefficiency in school catering services: over 15% of the overall processed food was not served to the pupils, according to their measurement. Nevertheless, only a few of the studies found in the literature aim to measure the efficiency or sustainability of the school food system, as most of them are focused on pupils nutritional intake, and therefore limiting the analysis to plate waste.

Table 3.3 Empirical research quantifying food waste in schools (% on total analysed studies)

Boundary	Research Scope	Research Objective	Methods	Indicators used
USA 75%	Plate waste 80%	Dietary Assessment 40%	Individual 69%	% waste on served 29%
UK 10%	Kitchen and plate	Drivers of Plate waste 30%	Aggregate 31%	% Consumed on served 17%
SPAIN 5%	waste 10%	Method comparison 10%	Selective 94%	Nutrients consumed or wasted 21%
ITALY 5%	Kitchen waste 5%	Economic cost of food	Non-selective 6%	Grams of waste per pupil 13%
AUSTRALIA 5%	Total Waste 5%	waste 10%	Weigh 69%	Waste economic value 13%
		FS efficiency 5%	Visual 31%	Total kilos of waste 4%
		Waste assessment 5%		Food surplus 4%

Plate waste measures show a considerable variation between the different schools (Wilkie, 2015). Typical results range from 20% to 50% of the food served being wasted, with vegetables and fruit in the higher range (Wilkie, 2015). For instance, Rodriguez Tadeo et al. (2014) did a research in Spanish schools estimating leftovers by visual estimation, being up to 26% of total served food and Byker (2014) obtained a 45.3% of waste on total food served. Other studies mentioned by Wilkie (2015) give results that range between 52 g and 227 g per pupil per day. He explains such differences were likely due to the different ages of pupils and methods of food service (Wilkie, 2015). It is interesting to point out that there was significant variability in the amount of food wasted during the week, vegetables ranged from 26.1% to 80%, depending on the day. Although researchers acknowledge some plate waste is unavoidable (Cohen et al., 2013), they agree that in excess is a sign of inefficiency or even irresponsibility (Buzby & Guthrie, 2002). The wide range of waste generation rates shown in these studies also suggest the need for more standardised waste audit methods to measure waste produced at school cafeterias.

From our review of the literature (n=20), we present a summary in table 3.3 of the most relevant features of the studies performed by researchers quantifying food waste in school canteens as well as their weight on the analysed studies.

3.3.3 Methods

The development of a standardised self-assessment tool should take into consideration the diverse frameworks in which school canteens operate which involve a set of complex social phenomena. In

order to analyse this complexity, we designed research with an explorative/inductive approach through primarily qualitative data as proposed by Pratt (2009).

With the purpose of developing a useful and practical assessment tool, we designed exploratory research in two phases. First, we collected data through qualitative research with a range of stakeholders in order to understand the factors that generate food waste at school canteens. Semi-structured, individual interviews with 12 managers and staff of 9 different institutions and collectives that play a role in school meals were conducted (see appendix B for details). In this first phase of the research we obtained insights from managers, both at schools and catering organisations from which a first draft of the tool was designed. In the second phase of our research, once the assessment tool was pre-designed, we tested it in four of the participating schools in the former phase, in order to validate and improve it. At the same time as the tool was being tested, we gathered the opinion of canteen and school staff through 9 further individual interviews as well as the opinion of 8 pupils too. Data collection was performed during November and December, 2014.

The sample selection of the first part of the study followed a strategy of quotas according to the type of school (semi-public, public and private institutions) and catering organisation. Due to the nature of the research, all schools should satisfy the following criteria: offer in-house cooked meals in a canteen and a minimum of 300 pupils having lunch daily at school. Catering companies had to have a revenue in Spain of at least 10 M € in the last year and a significant market share in the institutional food service channel. To identify our sample, we explored their web sites and existing reports and visited their locations. The final sample was made up of 4 catering companies and 5 schools in Barcelona city. Semi-structured interviews with school principals, canteen managers and food service organisation management were carried out (see Appendix B for interview and organisation characteristics). Due to the complexity of an analysis of this kind of process, we have developed a protocol as a conceptual and practical guide on data collection during interviews. The protocol proposes a semi-structured interview design with open questions and unlimited time in order to capture possible unexpected results and redirect the interview according to the responses of the interviewee. The questions were grouped in three sections; the first one about the management system, followed by specific questions related to each production stage (procurement, kitchen, service and waste disposal) and finishing with questions on their interest in applying reduction measures and best practices. The interviews lasted an average of 60 min and all of them were conducted in places suggested by the interviewees to maintain their comfort and privacy. In addition, the interviews were recorded using an audio recorder. The protocol also suggests the annotation of interviewees' reactions (e.g. behaviour or non-verbal communication) when responding to questions. The transcript of the interviews was conducted following a process of double review by the authors. In the second phase of the research, more informal interviews with school and catering staff as well as professors and pupils were conducted.

The next step was the codification of the interviews through the methodological proposals of Bogdan and Biklen (1997) implementing a qualitative data analysis software (MaxQDA). The first step of interview coding was to identify the blocks or paragraphs where the interviewees spoke about one of the elements suggested by Bogdan and Biklen, such as Setting, Definition, Process, and Method. This first coding allowed us to define the starting point from which we analysed the structure of each interview. The second step of coding consisted in assigning to paragraphs (or a part of them) a list of preconceived codes from the theoretical framework of the research. The initial list of codes contained 7 codes (Players, Places, Food Type, Waste Drivers, Initiatives, Waste Hierarchy, KPIs). The third and final step consisted in coding the paragraphs with a more inductive approach (encoding in vivo), recoding some of the interviews as new codes emerged. The final code book contains a total of 63 codes that classify data into 10 codes (the former 7 plus three new ones: Management, Resources and Culture).

After the encoding process, we analysed each interview and later we analysed them all in block following the suggestions of Miles and Huberman (1994) and Jurgenson (2005) with the goal of obtaining a specific vision of each case and a final conclusion for all cases. The first step of this

part of the analysis was to build a checklist matrix to coherently organise several components for every case. These matrices showed the different sources of data (interviews) in rows and the topics or codes (both the codes from the second and the third step of the coding process) in columns. The matrices allowed us to display the interviews of the codified elements and their reliability and 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. Based on the matrices, we re-analysed the assessment tool that we had previously developed. After the analysis of each case, we carried out a Cross-Case Analysis in order to enhance generalisability and potential self-execution of the outcome. Following a code-oriented strategy, we developed a Case-Ordered Effects Matrix (based on Miles and Huberman, 1994), which allows us to see how the effects play out across the seven interviewees. In other words, we could sort the seven cases and show the diverse effects for each case in the same picture. The matrix has the cases in rows and 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.

Once a first draft of the tool was developed based on the insights obtained from the qualitative phase of the research, we addressed 4 schools in Barcelona in order to test its performance and improve its deficiencies. The test lasted three to five consecutive weekdays at each school with the objective of comprising different menus and therefore avoiding potential bias due to meal preferences. The schools were selected so as to ensure different catering arrangements, medium to large size schools, public and private institutions and a mix of socio-economic statuses. The four selected schools for the trial each had an in-house kitchen in which daily meals were prepared managed by a specialised firm because this is the most common procedure at Spanish schools, as mentioned by C4 in our research. We weighed and measured waste from their canteens during 10 school days, in the four schools (Table 3.4). 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 placed. The schools in our sample had different cafeteria layouts but their lunch schedules were similar. 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. Children did not have the option of choosing their menu, except for secondary graders in school C.6 where they chose from two different options for each course. Special regime meals were usually also offered on demand. None of the schools offered a la carte items such as potato chips, as this very rarely happens in Spanish schools. Pupils in the study ate in one common lunchroom in three of the schools, while one of the schools had seven different lunchrooms. This latter school had 4 serving lines, two of the schools had one single serving line, and in one - school children were served by the staff at their tables.

According to Engström (2004), food waste at the canteens was collected and aggregately weighed separately depending on the point where it had been produced (pantry, kitchen, service station or plate waste), distinguishing whether it was avoidable (e.g. out of date ingredients, plate waste) or unavoidable (e.g. bones, peels) waste. Research assistants weighed the aggregated discarded food at each step in the process every day, recording total kilos as well as the approximate % of the different types of food. For this purpose, we used industrial transparent plastic bags (100 litres) so that research assistants could visually estimate the percentage of the different types of food once the bags were full. This was possible because, as mentioned before, the variety of dishes usually offered at school canteens in Spain in one day is limited, typically one entrée plus one main dish and one dessert or at the most two options of each, resulting in no more than three to five different food types per meal.

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. “Potentially avoidable” waste was differentiated from

"unavoidable" waste such as egg shells, bones, etc. and only potentially avoidable waste was weighed. For this purpose, rubbish bags were placed at different points of the kitchen with specific labels. 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 a Campesa K3 balance), as we did not measure unavoidable waste, in accordance with Papargyropoulou et al.'s (2014) suggestion.

We decided to combine a direct measure of waste method, aggregately weighing waste at the different collection stations with a less accurate method to measure food typology shares. Once total weight was measured, research assistants visually estimated the approximate percentage of total weight per food category. We opted for the aggregate selective method for its easy execution and simplicity, as schools should be able to implement it without external help later on.
Table 3.4 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 3.4 Trays and pupils audited

	Participating pupils	Trial Duration (# Days)	Elementary Pupils' trays	Secondary Pupils' trays	Total Audited Trays
School C5	986	5*	2,815	2,113	4,928
School C7	465	2	534	396	930
School C6	1,316	3	1,881	2067	3,948
School C8	225	1	225	0	225
TOTAL	**2,991**	**11**	**5,455**	**4,576**	**10,031**

*(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. We also performed 9 quick interviews with children eating in the canteen. The interviews in this case lasted 20 minutes on average with staff and 10 minutes with pupils and we encoded the transcripts following the same method and codes as in the former phase of the study.

The number of pupils actually eating lunch in the canteen each day was registered in order to be able to estimate the average weight per pupil and day, as this was the measure found by Wrap (2011) to be the most meaningful way to compare data from different schools. This figure was compared with the planned number of diners, a figure that we asked the cooks each audit day in order to assess potential food surpluses as suggested by Papargyropoulou et al. (2014).

It is important to recall that the primary objective of the auditing tool is to analyse and track food waste produced at schools, not the amount of food going in, nor the nutritional intake of pupils. Therefore, the output is given in grams of waste per pupil and not as % of waste on food prepared or served nor percentage of energy or nutrients consumed vs offered. Nevertheless, the tool can be easily adapted for these purposes.

3.4 Results and discussion

3.4.1 Perspectives on food waste by school caterers and canteen managers

We found a very low real awareness of managers on the amount of waste produced in the canteens. Only one of the schools in the sample had ever performed a waste audit at the canteen and only one of the participating catering companies does waste audits in the kitchens they operate in on a regular basis. This said we nevertheless found a high interest on the topic, especially among public funded

school managers and personnel: we appreciated that many school managers would be willing to implement initiatives to measure and minimise the amount of food wasted at their canteens, especially after observing our pilot-test results. It was acknowledged by the interviewed managers that food waste is a data-poor area and therefore when suggested, a waste inventory was reflected as the starting point for the application of reductive initiatives. They largely agreed on the fact that it would be useful to increase awareness on waste through the measurement and tracking potential of reduction initiative results.

Consistent with the literature (Wrap, 2011), avoidable food waste accounted for the greatest amount of waste generated at schools in our pilot test. Plate waste accounts for the biggest source of food waste, followed by food from serving lines. Average weight of food wasted per elementary school pupil in Barcelona ranged between 40 and 100 grams per meal and pupil. Secondary pupils' average waste was higher in two of the three secondary schools analysed, exceeding 80 grams daily waste per pupil in two of the four studied schools.

In our trial of the auditing tool, school's institutional and pedagogical principles showed a very direct influence on the amount of food wasted at the canteen. Some schools consider the canteen as part of their learning project and therefore try to educate children in finishing their food through different activities, training, and workshops. These schools resulted in lower levels of waste, and especially of plate waste. Conversely, whenever top management of the school did not consider food waste a priority, plate waste ratios were higher, at the same time as the level of awareness on the amount of food wasted was very low.

Just one school mentioned they regularly performed initiatives with the purpose of reducing food waste*: "We settle specific objectives every year. At present we are focusing on three food types: lentils, fish and oranges. Last year we achieved an important reduction on discarded bread. We are also currently focused on reducing dairy packaging, as its disposal costs are high"* (C6.1). In fact, in this school we found the lowest rate of plate waste in our pilot-test. We concluded this was due to the fact that its management had a strong focus on reducing food waste and this strong focus was translated into multiple ongoing initiatives.

Moreover, schools with a stronger management focus on sustainability, or with wider pedagogical objectives showed high interest in the results of our pilot audit at the same time as they declared their purpose of repeating the audit in the near future.

On the other hand, we also found food service providers with very different perspectives and visions on food waste. One of the food service managers interviewed, who worked for a catering company with a strong sustainability culture mentioned that school managers' scepticism and lack of awareness was a barrier for improving results: "Implementing sustainable initiatives is difficult sometimes, as schools are often not very sustainability conscious; We have had customer complaints when trying to reduce food waste arguing that our only purpose was to reduce our costs!" (C1.2).

She nevertheless recalled that when they had formerly performed waste audit assessments in schools, the results had been touching for both organisations and stated that it had been easier to introduce reduction initiatives in those institutions since then. We concluded from this that increasing visibility and awareness on food waste is crucial: *"We recently measured aggregated plate waste in one of our customers, one big sized school in Madrid resulting on a daily average of 350 kilos of food discarded. Then they launched an awareness campaign by putting together 350 kilos of packaged food ingredients at the entrance of the lunchroom with the purpose of increasing awareness on food waste among children"* (C1.2).

Moreover, we observed very different attitudes toward plate waste among canteen and school staff. Such attitudes range from strict control on pupils so that they completely finish their meal, to passiveness, acceptance or even denial of the real situation regarding plate waste. These diverse attitudes are also related to dissimilar school management ideologies regarding school meals: from those considering the canteen as a fringe service offered to the parents (with no educational responsibility by the school), to those who consider it as part of the school´s pedagogical mission. This is very closely related to the means and resources dedicated to minimise plate waste,

such as the number of caretakers and their role regarding leftover control and pupils eating habits as well as food waste reduction awareness campaigns.

We concluded from these observations that the role performed by school top management is the most relevant factor influencing sustainability issues such as the level of canteen food waste. Those institutions with a strong focus on sustainability or which were at an advanced stage on "greening" their organisations usually allocated more resources to reducing food waste and were thus more likely to be looking for performance indicators and initiatives to reduce waste. This was confirmed in our pilot-test, as the one school with a clear focus on sustainability recorded the lowest plate waste rate. The higher management focus on sustainability was translated into diverse procedures impacting the different waste driver areas, resulting generally in lower waste rates. Moreover, green conscious managers tend to be concerned not only with food waste but also with related packaging waste. An informative campaign addressing public funded schools with the purpose of increasing awareness on food waste could therefore be highly efficient.

Actually, as mentioned by Papargyropoulou et al. (2014) we verified that food waste arises at all the different stages as a result of very diverse causes and thus the ways to tackle them must be different too. We concluded from our research that food waste drivers can be categorised in three groups. First, those related to management practices such as the meal planning process or procurement practices. Secondly, infrastructures and equipment also impact food waste levels, especially at the storage and serving stages. Finally, human resources issues, such as staff awareness (or lack of awareness) on food waste is also reflected at the different levels of food waste in canteen operations. In the next paragraphs we shall develop these drivers, relating them to adequate indicators that will allow managers and researchers to measure and track performance in their related areas.

Regarding management practices, cooks and caterers mention communication between school and kitchen as key in order to accurately plan the number of menus to elaborate. As mentioned by C1.2, this is absolutely relevant for special regime diets such as allergenic: "Special *menus such as diet or allergenic produce higher amounts of waste per pupil than regular ones as they are more difficult to plan" (*C1.2). From this insight we can infer the relevance of tracking deviations between planned and real numbers of diners.

Also related to management practices we found menu planning closely related to food waste. In fact, many of the pupils interviewed complained about the quality of the food offered. Pupils' acceptance of food can be increased by menu planning policies. As suggested by C1.2: "*The different acceptance rates of dishes by pupils makes a difference. We try to balance our menus: if the first course is "difficult" (like for example chickpeas), the main course should be "easier" (for instance not offering fish)"*. Pupils' acceptance of meals can also be enhanced by giving them the option of choosing between more than one alternative for each course. Only one of the schools studied offered the pupils different dish alternatives to choose from.

On the other hand, procurement policies were admitted as closely related to waste. Suppliers' delivery frequency and product formats are managed to prevent pantry losses. Public policies were highlighted as a key potential tool to entice good purchasing practices at schools, although this was not clearly related to the generation of waste and should be tracked by selective measures of plate waste: "*Public procurement policies are aimed to guarantee that children have a diverse and complete diet, but effective food intake by children varies a lot between schools, closely related to school management priorities and consequent child education on food habits and supervision during meals*" (C2.1).

Research also shows that kitchen food waste is strongly influenced by school infrastructure and equipment. Caterers need to adapt their processes to school facilities and often complain that some of them are very old. They recognise this fact as a limitation: "*It is really hard sometimes*" (C2.1). Furthermore, the availability of recycling facilities strongly determines the destination of waste: "*Since we own a vegetable garden (year 2000), we compost most of the kitchen scraps and peels we generate*" (C8). Recording regularly the destination of food waste as well as its disposal costs might increase awareness on potential improvements. Waste bins at schools in our sample were normally emptied

into dumpsters. Although three schools in our sample had a vegetable garden, only one of them composted food waste from the canteen.

Better storage facilities were mentioned by cooks as a way in which they could reduce the amount of raw materials that had to be discarded, at the same time as it could also be a way of permitting excess cooked food to be stored for later consumption. We also found a relevant source of waste related to the number of serving lines in which children were served or where they could help themselves to food. Whenever there is one unique serving station, waste at this stage was significantly lower than when there were several. Schools with more than one service line tend to generate more food waste per pupil at this stage. This was due to the fact that all types of food needed to be displayed until the end of the service time at all service stations, inevitably causing a certain amount of waste at each station. One of the schools where we pilot-tested the auditing tool had four serving lines. Waste at this stage in this school varied significantly among the dates studied and we weighed over 70 kilos of cooked food not served that was discarded in one day. Bread has a relevant role here. Other studies (Betz et al., 2015) found serving waste to be the greatest part of food waste in food service (education sector). In our case study this was true for only one of the schools studied, and plate waste being the greatest part of food waste in the other three. Moreover, due to the fact that bread is low priced, no attention was paid in general to the amount discarded. In most serving lines, bread was placed at the beginning, together with the trays and cutlery, and diners used to take it before knowing whether they were going to like the menu. Bread was in our test one of the food categories with highest waste.

Finally, the role of canteen supervisors was emphasised as crucial, the lack of control on pupils leftovers being a relevant driver of plate waste. It was acknowledged that plate waste is closely related to effective supervision. Actually, schools with the lowest rates of food waste in our pilot were those where there was stricter control by canteen supervisors on top of a wider educational perspective. Measuring and tracking plate waste can be used by managers to encourage caretaker supervision. Managers therefore will find it useful to unveil the amount of plate waste as this will allow them to set reduction objectives and measure their effect or even compare results with other schools.

Tracking and disseminating these key performance indicators will facilitate school managers when choosing the most adequate correction measures and evaluating results. Necessary correction measures are different depending on the cause and the place where waste is generated. Table 3.5 summarises the most relevant school canteen food waste drivers and the indicators or variables that might be useful for running a diagnosis and describing the main improvement areas and help in the management of each of them.

Age is highlighted as a relevant factor too. Canteen staff and caretakers agree on the fact that children of different ages usually have different eating patterns. There was a consensus on the fact that younger children produce less plate waste, as stated by C.5. 4a: *"The younger they are, the more they eat. Three to five year olds leave no plate waste at all!"*. This insight shades light on the relevance of measuring waste from different collectives separately. Interestingly, even though the amount of waste generated per pupil varied a lot among the different schools, food wasted by elementary pupils was much lower than by secondary graders in our research. This result is consistent with the outcome of the first stage of our research although we found opposite results in several of the studies (Niaki, Moore, Chen, & Weber Cullen, 2017; Whatley, Donnelly, Jacobsen, Hill, & Carlson, 1996) mentioned in our literature review.

It is interesting to note that catering and school staff did not consider the proposed auditing method disruptive. On the contrary, cafeteria staff, teachers and caretakers who collaborated in the trial were proud to share their experience with other colleagues. They were often impressed by the results and willing to collaborate when ideas for food waste reduction were brought up. Research findings strongly support the relevance of sharing results with canteen staff, as suggested by the World Resources Institute (Craig Hanson et al., 2016).

Table 3.5 School food waste drivers and key performance indicators (KPI)

Related Area	Food Waste Driver	Management KPI
Institution Culture and Values	Top Management (low) Focus on Sustainability	Economic cost of food waste (€)
	Pedagogical Vision	Plate waste in g. per pupil
Management Practices	Communication between Kitchen and School staff	Deviations between real vs planned meals (%)
	Meal planning process	
	Menu planning (and acceptance of food by pupils)	Plate waste per food category (% of total plate waste)
	Procurement practices	Kitchen waste (Kilos)
Infrastructure	Kitchen equipment and facilities	
	Recycling & Reuse facilities	Waste use/method of disposal (%)
	Canteen Layout	Service and Plate waste (g. per pupil)
Human Resources	Supervision by caretakers	Plate waste ratios (g. per pupil and daily total kilos of waste)

3.4.2 Self-assessment food waste auditing tool

Based on our research, we can group the information to be measured and tracked when auditing food waste at school canteens, into four categories: accuracy of the planning system, physical measure of waste, waste destination and economic cost of food waste. In the following paragraphs we develop the four categories and describe related key performance indicators that should be included in a waste audit.

Accuracy of the planning system

Conformity between real versus planned number of diners should be measured, with the objective of analysing and tracking actual deviations between the information used by cooks when preparing food and the final amount of food needed at lunchtime. Differences between these two figures are often the cause of generation of food surplus (excess food cooked). In order to assess the accuracy of the planning system, we suggest using the following indicator: deviation rate between planned and served meals.

A daily estimation of the difference between planned meals and the real final number of diners should be tracked. For this purpose, a deviation rate should be recorded daily, noting both the number of planned diners before the cooking process begins and the actual number of effective pupils that eat at the canteen each auditing day. Deviations should be recorded in % of actual vs planned diners per shift (whenever there is more than one). Special menus such as allergenic or diet lunches should be recorded separately too. If there is a known cause for the deviation it should also be briefly explained in the record. Needless to say, elementary versus secondary grades should be recorded separately.

Physical measure of waste

Different food categories (e.g. fruit, bread, etc.) should be recorded separately in order to be able to assess the efficiency of the food service system as well as dietary and nutritional intake and food acceptance and preferences. This measure will shed light on the potential improvement that can be achieved by performing reduction initiatives and will be helpful for their design. Due to the nature of the physical measure of waste, we suggest two indicators, weight of food waste and number of zero waste trays, discussed below.

Aggregate and selective weight of food waste at each different stage of the process

This should be measured at each collection station, in order to differentiate the four typologies of waste: out of date produce, kitchen scrap, cooked but not served and plate waste, as explained in section 3.2.2. At each stage, potentially avoidable food waste should be measured separately from unavoidable waste, which does not need to be included in this record. Collection stations must differentiate the place and stage in the process where waste has been generated and categorised food should be recorded at each collection station. We suggest estimating the share (percentage on total food waste) of each food type by visual estimation. For this purpose we recommend the use of transparent rubbish bags for the aggregate measurement, recording the approximate % of each food category after weighing. To do this, we suggest using the classification used by Betz et al. (2014): meat/fish, starch, vegetables, fruit, desserts (e.g. yoghurt), and others, adding bread and legumes as separate additional categories. As mentioned before, unavoidable waste such as peels, bones, etc. must be separated at collection stations and withdrawn before weighing. Recording total weight of unavoidable waste is optional.

We shall therefore measure four different waste indicators in this section, one per each stage of the process:

a) Pantry loss: food waste generated in raw ingredient storage. We shall record the total kilos wasted at this stage, the approximate % of total weight per food type and the place where it occurred (e.g. pantry, fridge, etc.) as well as its alleged cause (e.g. out of date, spoilt, etc.)
b) Cooking loss: waste produced during the cooking process. Unavoidable waste should be discarded separately at this stage because only potentially avoidable waste needs to be weighed. Total kilos of avoidable waste should be recorded, as well as the approximate % per food type, the place of generation and the reason that probably caused it (e.g. burnt, aesthetics, etc).
c) Prepared food surplus: food cooked but not served. This comprises waste produced at serving lines or other means of distribution or display. Here, total weight of cooked food not served to the pupils should be recorded as well as the approximate percentage per type of food, noting the most probable reason that caused it as well as its most likely end: reuse (e.g. staff meals, soups, donations, …), recycling (e.g. compost), or disposal.
d) Plate Waste: Food Served but not eaten. We recommend measuring plate waste using the aggregated and selective method, once having withdrawn inedible food or parts of food. Again, total kilos of waste should be recorded before noting the approximate percentage per food type which will be measured by visual estimation.

We suggest weighing discarded food without separating the different types of food at each collection station, as categorisation can be visually estimated after collection by the use of transparent rubbish bags. This suggested method will ease audit implementation despite possibly being less accurate. This is consistent with the literature, as Smith (2014), in a study measuring individual plate waste, concluded that visual estimation was close enough to selective weighing when measuring plate waste. Due to the nature of the audit we prioritise easy execution over accuracy.

Nevertheless, plate waste usually being the main source of waste at school cafeterias, it can be helpful to deepen the analysis in a small sample of pupils, in order to get insights on the reasons that caused leftovers. This sample should be taken at random and it is recommended to take digital photos of these pupils' trays, both before they start dining and when they return their trays. The amount of plate waste found in this study is consistent with plate waste reported in previous research in schools although high differences were found among them. Moreover, most food waste types in our pilot study were legumes, vegetables and bread. This is consistent with the literature, as most studies highlight the high waste of vegetables.

Although the aggregated method is recommended for its convenience, results should also be given in grams per pupil, calculating the ratio between total waste kilos and the number of real diners, using the figure of real diners previously recorded.

Number of zero waste trays, as a percentage of total trays

Tracking how many pupils empty their trays completely will shed light on meal acceptance and caretakers' control. Moreover, the study suggests the dissemination of this information may encourage other pupils to reduce plate waste: *"Since we started the zero tray project (a contest among classes in which the class with a higher percentage of fully empty returned trays were rewarded), plate waste has been reduced significantly" (*C.6.1).

Waste destination or use

Improvement opportunities can also arise by noting and tracking the destination of waste from the canteen. Good sustainability initiatives could include setting objectives of reducing waste sent to landfills and reducing food waste footprint by reducing waste that is discarded at the lower levels of the waste hierarchy pyramid. The indicator proposed to manage waste destinations is simple. We recommend recording the way food waste is discarded (e.g. rubbish bin, reuse, compost). The waste destination indicator implies noting the approximate % of waste which will probably end in landfills, compost or that will be reused, recording its intended purpose in this case. Whenever more than one disposal method is used, the approximate % on total waste weight of each one should be recorded.

Economic cost of food waste

An economic estimation of food waste is recommended as it will increase the relevance that school and catering managers give to tracking and measuring waste as a means of reducing food waste could be seen as a potential profit increase. As mentioned by one of the caterers in our sample C1.1: *"Canteens are a source of business for schools, they make profit out of them" (*C.6.1). School managers with a low focus on sustainability, and therefore not motivated to reducing food waste for sustainability related reasons, may find an attractive incentive in this indicator. The approximate cost of waste can be calculated in different ways. We suggest using an average cost per meal estimated on a year basis (including procurement and service) and multiply it by the equivalent of meals thrown away. This can be calculated by dividing the total kilos of waste (section 2 of the audit) by the average weight of meal (g) and multiplying the result by the average cost per meal. This should be done with the support of the financial manager. Although this method may not be accurate as it does not distinguish the diverse cost of different food ingredients we prioritise ease of execution over accuracy due to the purpose of the measurement.

By tracking appropriate KPIs related to the above mentioned four areas and their probable causes, school caterers and managers will be able to diagnose and describe main improvement areas. Materials needed in order to perform the audit include a scale, six labelled waste bins or waste containers and transparent rubbish bags.

Table 3.6 summarises the four main data categories, relating them to the goal of the analysis and their related KPI. In the following paragraphs a detailed explanation of the auditing tool is offered, while the tool itself is included in Appendix C.

Kitchen and service staff highlight that there are some dishes which typically generate low or no plate waste, such as rice or pizza, while others such as fish or vegetables generate high plate waste rates. Despite menu planning often taking this into consideration, we found a wide range of plate waste ratios on different dates, a fact that we attributed to the different acceptance of the menus. Plate waste one day in a specific school could double or even triple a previous day's ratio. For this reason auditing a full school week is urged in order to include diverse meals and avoid bias due to

different meal acceptance from pupils. Strong differences were also found among the sample schools in our pilot-test.

Table 3.6 Summary of selected KPIs and their purpose.

Data Category	Purpose	Food Waste Indicators short list
Accuracy of the planning system	Better adjustment of quantities cooked	1. Planned vs real number of meals
Physical measure of waste	Assess system efficiency & dietary intake	2. Selective aggregate food waste by type of food 3. Zero waste trays
Waste destination	Reduce environmental impact	4. Food waste destination
Economic cost of food waste	Increase awareness of Food Waste Relevance to management	5. Total Euros/Dollars/Pounds in cost of food waste

Once the audit is finished, it is recommended to share the results with professors, supervisors and pupils as this would contribute to increase awareness on the issue. Lack of visibility and therefore lack of awareness is one of the key reasons for the low level of measures taken to reduce food waste in the food service channel (Derqui et al., 2016). The first measurement will be used as a baseline and the reference for improvement goals. Successive measurements will shed light on the efficiency of initiatives as well as on the room for improvement. We suggest that the audit project be led by a "champion" or person in charge who will be responsible for coordinating the different players needed for the success of each improvement initiative.

3.5 Conclusion

As suggested by Gerbens-Leenes et al. (2003), it is important to bridge the existing gap between theoretical scientific knowledge and practical company knowledge in measuring sustainability. Nevertheless, as they state, this is in general difficult, as research as a rule emphasises accuracy and completeness while business needs easy to handle, practical and cheap tools to assess their sustainability performance (Gerbens-Leenes et al., 2003). Through our research, we designed a self-assessment tool that can be easily used by schools and caterers to measure and track food waste at school canteens yet comprehensive and accurate. In addition, through the implementation of the tool, academics will have further relevant quantitative and comparable data as well as visibility to food waste, a field of information which is not widely available. Moreover, managers and researchers can adapt and use the tool in different countries and environments in order to obtain metrics and insights on food waste and benefit from benchmarking and shared experiences under homogenous criteria and standardised concepts.

Our paper provides new contributions to the literature on food waste. Firstly, a standardised and easy to implement self-assessment tool is developed to be implemented at school canteens. Secondly, it sheds light on the potential good acceptance that sustainable initiatives may get from school managers and staff. Finally, it relates food waste drivers to key performance indicators that would help managing potential initiatives to address them. On the one hand, our main contribution for researchers is the availability of a standardised tool that will permit the comparison of food waste assessments in schools among different cities and environments. On the other hand, we provide school and food service managers with an easy to implement tool that will help them along their path towards more sustainable organisations.

CHAPTER 4

ADDRESSING FOOD WASTE AT SCHOOL CANTEENS

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 (Östergen, Gustavsson, *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 et al., 2015), or undervaluing food (Finn, 2014).

4.1 Introduction

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 et al., 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 three-stage 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, and finally, we conducted a quantitative research in which we obtained 420 responses from school headmasters/headmistresses,

hereinafter referred to as headteachers of schools with a canteen. 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.

4.2 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 topic of public concern as well as of research. Needless to say, a perfectly nutritionally designed menu is useless if leftover. This becomes particularly critical when we consider different food types, as leftovers are often the healthiest plates (Betz et al., 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. 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, 2015). Additional research is needed about how to maximize 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).

4.3 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 prioritize 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 et al., 2016).

This said, the amount of food wasted at schools has been the object of numerous studies, which shed light on the relevance of addressing this topic at school canteens. Striking results were 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 et al., 2005; S. L. Smith & Cunningham-Sabo, 2014), reaching similar results: over 40% fruit and over 30% served vegetables 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 at this US 1996 study were more likely to report that plate waste was at least a moderate problem than were 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 in 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 prioritize the economic dimension of food waste which is often hidden (Mena et al., 2011), thus increasing visibility though waste audits should be the first step towards reducing waste.

4.4 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 et al., 2015). Several studies at 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). Described causes of plate waste 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 WRAP (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.

Behavioural drivers are likely to be modified through educational or awareness campaigns. Actually, Yoon and Kim (2012) did 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 that 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 4.1: Food waste driver categorization

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

Motives reported in the literature to reduce food waste include saving money, saving the planet, save hungry people and save guilt (Aschemann-Witzel et al., 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 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´ preferred meal option accompanied by surveying consumers´ 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 in 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 and limiting availability of competitive food items (Marlette et al., 2005). 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 incentivized 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 minimization 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 weighting plate waste, results displayed in the dining room and teachers discussed

food waste in their classes - led to a 35% reduction in plate waste. 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 incentivized by different stakeholders, or even by collaboration initiatives among them (Priefer, Jörissen, & Bräutigam, 2016). Engström highlighted the fact that those schools that practice a "pedagogical lunch", being teachers engaged in teaching children how to behave in the dining room and discussed 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. Actually, publicly funded schools, guided by local governments, often require their catering suppliers a minimum percentage of organic products, stimulate proximity produce (Km zero), among other sustainable practices (Mikkola, 2009).

Table 4.2 Examples of interventions to reduce food waste at schools suggested by scholars and their related motivation

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

4.5. 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 give 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 gives light on the potential impact that an educational awareness campaign could have in a huge number of future consumers, in the effort towards a more responsible & 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 shed light to this Research Question, we put forward the following Research Objectives:

1) To identify the different business models operating at present at school canteens and their influence on food waste generation.
2) To understand the types and nature of food being wasted as well as at where in the process waste is generated.
3) To shed light on the causes that lead to food waste at school canteens.
4) To Identify initiatives and practices that could lead to reduce food waste at school dining facilities, and
5) To prioritize them based on their potential acceptance by school managers.

4.6 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 three 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 to managers and staff of different institutions through an explorative/inductive approach as proposed by Pratt (2009), with the purpose of obtaining insights about 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.
3) A quantitative survey among school principals designed to analyse their perceptions towards the recommended actions and initiatives to reduce food waste that were listed in the first and qualitative phase of the research as well as their potential interest in implementing them. A deductive approach was needed in this case on order to validate the findings of the qualitative part of the study and to be able to rank and prioritize the suggested interventions based on a representative sample.

The first research stage was conducted through in-depth interviews with 12 managers and staff of 9 different institutions and collectives that play a role in school meals, both at schools and catering organisations (see appendix B for details). At this stage, we also performed 9 further individual interviews in order to gather the opinion of canteen and school staff too. We followed a strategy of quotas according to the type of school (semi-public, public and private institutions) and catering organisation to choose the sample. Schools should satisfy the following criteria to be eligible for the sample: offer in-house cooked meals in a canteen and a minimum of 300 pupils having lunch daily at school, and catering companies had to have a revenue of at least 10 M € in the last year and a significant market share in the institutional food service channel. Semi-structured interviews lasting about 60 minutes each were carried out with school principals, canteen managers and food service organisation managers in the 8 institutions that conformed the final sample: four catering companies and four schools in Barcelona (see Appendix B). Due to the complexity the analysis, we developed a protocol as a conceptual and practical guide on data collection during interviews. The protocol proposes a semi-structured interview design with open questions and unlimited time in order to capture possible unexpected results and redirect the interview according to the responses of the interviewee. We grouped the questions in three sections; the first one about the management system, followed by specific questions related to each production stage (procurement, kitchen,

service and waste disposal) and finishing with questions on their interest in applying reduction measures and best practices. The interviews were conducted in places suggested by the interviewees to maintain their comfort and privacy. The protocol suggests not only to audio-record the interviews but also the annotation of interviewees' reactions (e.g. behaviour or non-verbal communication) when responding to questions. The transcript of the interviews was conducted following a process of double review by the authors. Then we coded the interviews through the methodological proposals of Bogdan and Biklen (1997) implementing MaxQDA qualitative data analysis software. Our initial list of codes contained 7 codes (Players, Places, Food Type, Waste Drivers, Initiatives, Waste Hierarchy, KPIs) and we finally coded the paragraphs with an inductive approach (encoding in vivo), recoding some of the interviews as new codes emerged. The final code book contains a total of 63 codes that classify data into 10 codes (the former 7 plus three new ones: Management, Resources and Culture).

Following the suggestions of Miles and Huberman (1994) and Jurgenson (2005), after the encoding process, we analysed each interview and later we analysed them all in block with the goal of obtaining a specific vision of each case and a final conclusion for all 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 and their reliability and 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 and 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 and 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 waste audit in four of the participating schools during three to five consecutive weekdays per school with the intention of comprising different menus thus avoiding potential bias due to meal preferences. We weighed and measured waste from the selected school canteens during 10 school days (Table 4.3). The schools were selected so as to ensure different catering arrangements, medium to large size schools, public and private institutions and a mix of socio-economic statuses. The four schools had an in-house kitchen in which daily meals were prepared managed by a specialised firm because this is the most common procedure at Spanish schools, as mentioned by C4 in our research. 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 placed. The schools in our sample 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. Menus were fix and therefore children could not choose their menu, except for secondary graders in school S2 & S3 (See Appendix B) where they chose from two different options for each course. Special regime meals were usually also offered on demand. None of the schools offered a la carte items such as potato chips, as this very rarely happens in Spanish schools. One of the schools had seven different lunchrooms and four serving lines, while the three other schools had one common lunchroom. Two of the schools had one single serving line, and children were served by the staff at their tables in only one school.

We collected and aggregately weighed food waste separately depending on the point where it had been produced (pantry, kitchen, service station or plate waste), as suggested by Engström (2004), distinguishing whether it was avoidable (e.g. out of date ingredients, plate waste) or unavoidable (e.g. bones, peels) waste. 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.

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. "potentially avoidable" waste was differentiated from "unavoidable" waste such as egg shells, bones, etc. and only potentially avoidable waste was weighed for the sake of simplicity. Rubbish bags were placed at different points of the kitchen with specific labels in order to be able 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 a Campesa K3 balance), 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. Table 4.3 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 4.3 Trays and pupils audited

	Participating pupils	Trial Duration (# Days)	Elementary Pupils' trays	Secondary Pupils' trays	Total Audited Trays
School C5	986	5*	2,815	2,113	4,928
School C7	465	2	534	396	930
School C6	1,316	3	1,881	2,067	3,948
School C8	225	1	225	0	225
TOTAL	**2,991**	**11**	**5,455**	**4,576**	**10,031**

*(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 daily the number of pupils actually eating lunch in the canteen in order to be able to estimate the average weight per pupil and day, as this was the measure found by Wrap (2011) to be the most meaningful way to compare data from different schools. This figure was compared with the planned number of diners, a figure that we asked the cooks each audit day in order to assess potential food surpluses as suggested by Papargyropoulou et al. (2014).

Although a priority was given to qualitative data, finally, and with the main purpose of achieving our objectives number 4 & 5, and as the third stage of our pragmatic mixed methods approach, we performed a quantitative research through a questionnaire sent by email to 5,000 school principals in Catalonia (Spain). The data and collected results from the previous stages of the research were used to set the precise objectives of the survey. The sample was chosen from official open access databases. We used a stratified sample in order to guarantee the presence of diverse schools, including public and private schools, with both primary and secondary students, as well as the different catering systems. We got 548 valid responses out of which, we used for our research only the responses that came from schools offering dining services to their students, which were 420. The structure of the questionnaire was as follows: In section one, we asked personal (name and position of the respondent) and institutional information (number of pupils, whether the school had a canteen, and whether it had a sustainability certification of any type). Section two included questions on how the canteen was managed, the number of students that usually used it as well as

if they performed food audits. Section three aimed to understand the school`s vision towards sustainability, including questions related to the amount of resources and efforts they dedicate to sustainability issues. Section three aimed to understand their perspective on food waste, trying to understand how relevant the issue is in their institution as well as who they consider responsible for trying to reduce it. Finally, in section four, several interventions were listed and respondents had to grade them using a 5-point Likert scale based on how interesting they perceived them to be applied in their school.

Data collection of phases one and two of the research were performed during November and December, 2014, while the quantitative phase of the study took place during February, 2017. Both qualitative and quantitative data collected were integrated. The reliability and validity of this study are strengthened through use of triangulation of methodologies and data. Nevertheless, the limitations of this research relate to three aspects: the waste audit was conducted in four 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. Finally, we were only allowed to measure kitchen and pantry waste in two out of the four participating schools.

4.7. Results & Discussion

4.7.1 Compositional analysis of food waste at pilot schools

Overall food waste was estimated in our research to be between 60 and 100 grams per pupil and 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 and day in primary schools and from 23.7g up to 88.0g per pupil and day in secondary schools. 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 6 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 4.4, where we present separately the results obtained in Primary and Secondary schools due to its relevance.

Although plate waste was found to be the biggest source of waste in all the case studies in our research, we observed a significant difference between those schools which declared the canteen being included in their educational curricula (S.2 & S.4), this meaning the school`s aim to educate students in eating behaviour and patterns, as a part of their holistic educational perspective and those in which the canteen was considered a fringe service offered by the school, and not related to the pupils curricula. We found a significant influence of this fact on the level of plate waste found in the audit. In fact out of the four schools measured, only in school S.3 management spoke passionately about sustainability, had a food waste responsible ("champion") and was currently implementing initiatives to reduce waste. Plate waste at school S.3 was found to be significantly low compared to the other three schools.

Given this, we concluded from our research that the 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 principals` focus on sustainability. This resulted to be a much more relevant factor compared to others such as the catering system, school size, etc. Consistently with Engström (2004), schools that produced less waste in our sample had in common the consideration of the canteen as part of the schools´ pedagogical program 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.

Table 4.4 Compositional waste at school canteens

Primary School Avoidable Food Waste				
	School 1 (S1) (grams per pupil)	**School 2 (S2)** (grams per pupil)	**School 3 (S3)** (grams per pupil)	**School 4 (S4)** (grams per pupil)
Kitchen discards	3.7	7.3	ND*	ND*
Service Leftovers	6.1	Wide range (between 8 up to 65)	ND*	ND*
Plate waste	47.0	32.0	46.0	38.0
TOTAL AVOID. FW	56.8	From 36.3 to 93.3	ND*	ND*

Secondary School Avoidable Food Waste			
	School 1 (S1) (grams per pupil)	**School 2 (S2)** (grams per pupil)	**School 3 (S3)** (grams per pupil)
Kitchen discards	3.7	7.3	ND*
Service Leftovers	6.1	Wide range (between 8 up to 65)	ND*
Plate waste	82.5	47.0	88.0
TOTAL AVOID. FW	92.3	From 62.3 up to 119.3	ND*

*We were not allowed to measure kitchen waste in schools S3 & S4

Plate waste was therefore found to be the main source of avoidable waste. We found a significant difference between plate waste left by primary and secondary pupils. Consistent with Reger (1996), secondary school students wasted more than primary school pupils. Results regarding the comparison between students of different ages differ: several scholars, such as (Dillon & Lane, 1989; Guthrie & Buzby, 2002; Niaki et al., 2017) found that younger students tended to waste more than elder children, while others such as Reger (1996) reached the opposite result. We observed in our research a significant increase in plate waste with pupils´ age. In our study, plate waste mass was close to double in secondary graders` trays compared to primary graders`, leading us to the conclusion that the elder the child, the higher plate waste, as mentioned by S.4 & S.1.3 in the qualitative part of our research. This result strongly supports the relevance of awareness and educational campaigns. Secondary students waste rates were much higher than primary's.

With regard to recess schedule, our results differ to Getlinger´s (1996) who argued that plate waste rates could be reduced if a recess was planned before lunch. This is probably attributable to cultural reasons as many students in Spain bring a sandwich or a snack from home to be eaten during the midmorning recess. Whenever such recess is close to lunch time, kids are less hungry and thus plate waste rates are higher.

Vegetables, legume and bread form the largest proportions 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 reducing food waste, as reckoned by our interviewees.

4.7.2 Factors that determine food waste at schools and related interventions

From the results of our research, consistently with Wrap (2011), we classify food waste determinants into three groups: firstly, behavioural factors among which the managers` standpoint towards food waste and sustainability in general outstands; 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 food waste drivers and interventions classification.

Increased awareness and education to address behavioural factors

Managers` vision, restrictions and priorities can be a relevant food waste driver as school principals and institutions may have very different visions and management styles as well as diverse perspectives on 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!" (C.7).*

Pedagogical orientation was found in our research to be the most relevant factor in this area: the more sustainability focused 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 its success, something that rarely happens when school principals do not have 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 when there was an explicit policy on when a student can leave the dining room, plate waste was reduced.

With regard to commercial catering organizations, 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"* (C.1).

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" (C.6)*. This may generate food waste at suppliers` place and could be reduced by awareness campaigns, teaching children about the goodness of produce regardless their shape.

Interventions aiming to minimize 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:

1) 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.
2) 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.
3) Education on food waste issues, with focus on its ecological footprint.
4) Increase pupil´s engagement, for example by allowing them to vote Friday`s menu among several options.
5) Food workshops such as teaching kids how to peel fruits, tasting new flavors or bringing them closer to the kitchen process so that they give more value to school food.

6) Friendly competitions such as the "zero waste tray contest", in which groups of students with higher number of no waste tray get small rewards and recognition.
7) Using "waste calculators" in order to estimate economic cost of waste.
8) Engaging staff including food waste topics in regular meetings so that they are encouraged to provide ideas to minimize waste.
9) Waste awareness initiatives aiming to make waste more visible and therefore increase pupils´, teachers´ and staff´s awareness on the problem. Kitchen posters and signage could be an intervention example.

Optimized operations to address managerial issues

We found two different types of drivers 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.

Different models for catering provision typically include contracting out to commercial catering companies, even when the school has kitchen facilities: "*Over 60% of the school canteen services are outsourced at present in Spain" (C.4).* 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*" (S.4); *" 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 perceived quality of food is higher when freshly made.

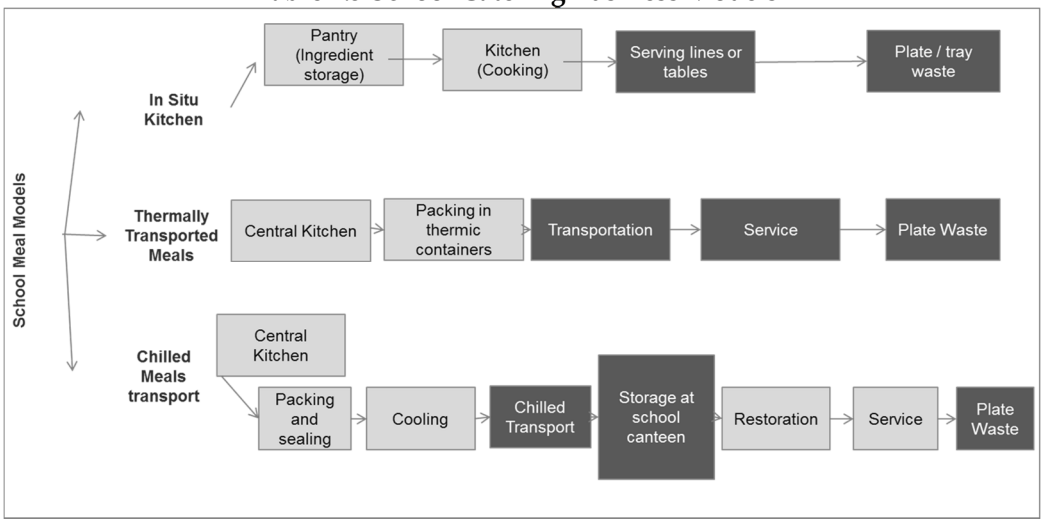
Aside from plate waste, the amount of waste produced as well as where in the process it is mostly produced, varies depending on the business model:

1) In 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, school acts as the operational centre as 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 independent service by school staff: "*We subcontracted the service because we are experts in education, not in catering!; Waste was significantly reduced since we outsourced the kitchen service*" (C.9).
2) 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 pasteurized. 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 centralized 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"* (C.1).
3) 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 4.5, where critical points for the generation of food waste are highlighted.

Table 4.5 School Catering Business Models*



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

Managerial issues affecting food waste include menu and demand planning, as well as portion management. On the first hand, 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 children 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 as 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 has also 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 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 found to be closely related to the accuracy of demand forecast (number of diners) as well as to kitchen staff awareness on food waste. A fluent communication between the school and the kitchen is 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 on 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 *only serving staff "forgives" two chickpeas to each pupil, it would mean 3.000 chickpeas 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 importantly 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 minimization initiatives related to operational issues include aspects such as demand planning and procurement, diversity and meal acceptance by students or optimized portion sizes.

The following best practices were suggested with regard to managerial aspects:

1) Menu planning having waste minimization in mind, including practices such as planning the menu of the day based on previous day`s ingredient surpluses.
2) Menu planning can also be optimized 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.
3) 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.
4) 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 eating school dinners each day (accurate prediction was considered challenging by cooks). A better communication will help predicting the amount of each meal option that will be required.

Special attention was drawn to demand planning and to adjust procurement consequently. This can be optimized through interventions such as using efficient demand planning software and daily supervisions, among others.

Resource allocation and regulation to minimize situational divers

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 regulation and contract liabilities.

Resource availability

School food waste is influenced by catering companies and institutions` diverse resources either physical (facilities) or human (teachers, supervisors, cooks). Some of these resources are structural, such as the size and equipment of the kitchen or the dining room, while human factors, such as staff implication and availability are more closely related to the principal`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 influencer. We also found that the smaller the school canteen, the easier it resulted to adjust menus and adapt it to children 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, specially 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 plate waste*" (S.3.1). Another relevant factor is previous scheduled recess time. As many kids eat a sandwich (brought from their homes) 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 as the most critical factor influencing food waste. 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 empting their plates. This practice was observed in our case study in schools S2 & S4. Moreover, caretakers oftentimes 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 specialized and well dimensioned. The following best practices were suggested in this area:

- Hiring a meal supervisor team with this specific function.
- Training programs for supervisors.
- Use of physical systems to minimize 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 in site.

This said, we also found that plate waste rates significantly differ among different geographic areas basically due to the diverse socioeconomic level of the families: "*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).

Regulation 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 usually disincentive donors by 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 organizations.

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.

4.8. Intervention prioritization by school principals

With the aim of prioritizing and evaluating the above mentioned potential interventions to reduce food waste at school canteens, we launched a survey addressing principals of both public and private

schools and got 420 answers. We asked them to rank from 1 to 5 their interest in applying the proposed list of initiatives in their schools. Here we have considered the top two boxes, thus ranking the initiatives based on the percentage of 4 and 5 (agree and completely agree) answers that each of them got.

47% of the interviewed school principals in our survey agreed that some kind of intervention should be applied in order to reduce food waste in their school canteen (top two box). We asked them to grade a short-list of potential waste minimization interventions based on their interest in their application at their schools. A ranking of the preferred interventions and their percentages of Top Two Box responses is shown in Table 4.6.

Table 4.6 Intervention Prioritization

Waste minimization intervention prioritised	% Ranked 4 or 5
Increasing the number of caretakers at lunchtime	51%
Enhancing compost or food donations	45%
Workshops to teach kids how to peel fruit	43%
Improve school – canteen communication	28%
Contests among groups of students such as zero waste trays	25%
Optional side-dishes	23%
Not giving bread to pupils until they have finished their meals	18%
Improving choice by pupils	16%

The chosen initiatives are diverse and show different perspectives and therefore, we do not observe a clear typology of interventions to be prioritized over the others.

Although only 15% of the respondents ranked top two boxes to the statement "A lot of food is wasted at school", interestingly, 52% agreed on the need of measuring waste and were interested on performing waste audits. This is consistent with our previous research (Derqui et al., 2016) in which we concluded on the low visibility of food waste to management in food service organizations as well as with Cooke et al. (2011) who stated that people do not like to waste food because it makes them feel guilty.

4.9 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 the highest source of food waste at schools. It is mostly avoidable and very strongly influenced by school´s educational perspective. School principals, canteen supervisors and teachers play a relevant role in facilitating, designing and implementing waste minimization interventions. The human factor has arisen as the most relevant one when aiming to minimize food waste.

Interventions at schools have a double-fold benefit: first, school canteens have been proved as a very relevant source of food waste, shading light on the potential benefit of implementing minimization 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 categorize school canteen food waste drivers and list related interventions. Second, we shed light on the key stages where waste is produced differentiating by catering business model.

CHAPTER 5

FINAL CONCLUSIONS AND FUTURE RESEARCH

Increased population and increased consumption in a truly finite world is the new equation to be solved by us humans. Business managers are at present considered the principal actors in achieving sustainable development and most executives know that the way in which they respond to the challenge of sustainability will profoundly affect the competitiveness (Lubin & Esty, 2010), and perhaps even the survival of their organizations. Kotler (2011) stated that in order to embrace sustainability, companies need to change their management practices. This is valid both for food service organizations - among which catering firms are included – and for institutions such as schools, regardless of whether they are public or privately funded. At the same time, sustainability is such a broad concept that measuring firms` performance is often difficult for managers and other stakeholders in this matter. In fact, many managers would appreciate the availability of practical tools to help them measure and prioritize their sustainability policies together with clear indications or access to best practice recommendations as a guide in their path towards more sustainable organizations. Moreover, setting appropriate goals, monitoring and evaluating progress would help managers in the adoption of sustainable policies.

Each different business addresses sustainability and its social responsibility in a unique way, mostly following its leader´s or top management profile. One of the main conclusions of our research, is that corporate sustainability is more closely related to the personality and goals of the executives who manage the organization, than to the dynamics of the industry where it is competing, or even to market drivers. The role of top management in the sustainability of an organization is crucial. It makes the difference in how businesses respond to the new environment we all face. But managing is about making decisions based on facts and when it comes to sustainability, clear and compelling facts are not always on the table.

Food waste is still a data poor area. There is an important lack of visibility and awareness on how much food we are discarding at all levels. Measuring tools shading light on the sustainable performance of a firm turns out to be the very first move towards sustainability. Being efficiency one of the main drivers for management decisions, providing managers with an improved visibility of waste will help them making decisions on how to minimize it. Through this research, we confirm the hypothesis that business decision makers generally prioritize the economic dimension of sustainability over the other two. They may consider social and environmental dimensions of sustainability as secondary (Bansal, Pratima; Roth, 2000); the problem is that very often the economic dimension of sustainability, and very specially of food waste, is not apparent. On the other hand, not profit-driven institutions such as schools, may prioritize the social dimension of sustainability and therefore, different incentives may be used to achieve the same goal.

Corporate sustainability performance is usually influenced by supply chain actions, collaboration among the different players along the value chain is therefore essential. Food waste

occur across the whole food supply chain. Interventions in one stage may have an impact on the previous or the following stages and therefore, cannot be analysed separately. Sustainability mature organizations embed their value chains through different types of collaboration to achieve their sustainability goals. A crucial way in which collaboration can be enhanced is through education and awareness campaigns. Education on sustainability may be a substantial part of such collaboration, specially promoting sustainable consumption.

Food waste is a global issue of such a magnitude that it becomes urgent to tackle it. We cannot afford to waste so much food. Food waste is inacceptable for ethical, environmental and economic reasons: reducing it would improve food security worldwide, food waste is a greenhouse gas generator as well as an inefficient use of resources-. Despite this, huge amounts of food are wasted across the food system.

School canteens are causing at present an important quantity of food waste. Based on the result of our research, primary graders waste between 60 and 100 grams of food per day and secondary graders between 92 and 120 grams on average daily each. This makes an impressive figure if we consider that there are at present 800,000 primary students and 162,000 secondary pupils having lunch at school in Spain on a daily basis. This results in between 10 and 15,000 tons of food wasted annually in Spanish schools. Obviously, a big impact may be achieved when tackling food waste at schools or other places where there are many people dining at the same place. Food service corporations and most importantly at the institutional catering industry (schools, hospitals, prisons) present thus a great opportunity for improvement. Despite this, slow progress has been made in the last decades to reduce food waste.

Additionally, 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.

We found two different areas of action to address food waste. The first one consists in tackling pre-consumer waste, through initiatives which are, in the case of businesses very closely related to their impact on profitability. Managers will definitively take measures to reduce pre-consumer waste as long as they are aware of how much is wasted and can translate this into costs and potential improved efficiency. This is in fact a strong motivator for reduction initiatives for most businesses. This said, we also found in our research a few corporations that were driven by environmental and social sustainability perspectives. In all such cases, we found high sustainability conscious and implicated top management. Institutions and NGOs are usually not so much driven by the economic dimension of sustainability although it is still relevant for them. This said, it is essential to improve the visibility and awareness of waste in order to be able to make improvements in this area.

The second area of action regards post-consumer waste, which is often not prioritized by food service firms as they do not perceive it so closely related to business efficiency and most of the times they are not aware of its real volume nor of its impacts. Reducing this type of food waste can be achieved by educational and awareness campaigns. Not for profit organizations such as most schools, managed by a sustainability conscious leader usually prioritize social and environmental dimensions of waste when making decisions, and thus are more prone to implement reduction measures once they are aware of how much food they waste in their canteen.

The crucial role of top management and their perspective on the sustainability performance of their organization is a key conclusion of this work. More sustainability oriented managers will embed sustainability in all areas of their organizations and push social and environmental initiatives across the organizations. Nevertheless, such initiatives are often difficult to manage due to the lack of clear key performance indicators and measurement tools. Our food waste self-assessment tool will help managers and school principals unveil real amounts of food waste in the canteens at the same time as it will ease tracking the result of reduction policies. Aside food waste, the development of easy to implement sustainable performance tools is one of the key avenues for future research in sustainability.

The definition and dissemination of best practices to help managers in their path towards more sustainable organizations is also a quick win. Sustainable conscious managers are willing to adopt interventions that are not very disruptive with the goal of improving the sustainability of their institutions. A key path to success is therefore to increase the awareness of principals and other managers on the issue of food waste and disseminate best practices.

Interventions to minimize food waste in the food service industry were grouped in our research in three categories: first, those related to business and management processes such as improved demand planning systems. Second, collaboration initiatives across the supply chain, such as supplier – retailer joint projects as well as collaboration among the different players in the catering process such as school –kitchen communication or even including pupils in the menu decision process. Collaboration with local governments with the aim of including food waste in the regulation processes would also be included here too. Finally, a third group of interventions are related to increasing visibility and awareness on the topic to decision makers at all levels. The latter can be enhanced through educational campaigns and therefore, schools are confirmed as a key player to improve the sustainability of the global food system. Moreover, transparency is a must when dealing with sustainability issues. Dissemination of clearer and fact based recommendations to improve the sustainability of organizations of all kinds is needed to ease the application of improvement measures.

Finally, a relevant food waste driver in food service in Spain is that donations are legally dis-incentivized. Legislators, corporations, citizens, NGOs, etc. will need to sum up efforts in order to find innovative solutions to this global issue. Addressing global sustainability challenges is beyond the capabilities of governments and even of the biggest corporations. Businesses and other stakeholders must collaborate in new ways to create shared value and address environmental problems. Collaboration is the new imperative. Successful initiatives will probably involve employees, suppliers and even customers. For instance, school catering industries must work hand in hand with schools to reduce the amount of waste produced at schools.

Improving the sustainability of businesses and institutions is a must, not only for our responsibility with future generations but also to guarantee the organization`s endurance in the near future.

5.1 Additional research avenues

Further research is needed on potential incentives to business management aiming to facilitate the implementation of sustainability policies and strategies. In particular, in the food service sector, future research should shed light on potential ways to increase the visibility of food that is wasted, and possible inter-stage collaborations with the common goal of minimizing waste along the value chain. Very closely related to this area of research, further studies are needed on business sustainability performance metrics and their influence on decision making.

Another avenue for future research is packaging waste in the food service sector, and potential supplier – operator collaborations to improve the global sustainability of the food system.

With regard to schools, additional research is needed about how to maximize the role of school catering and academic staff and enhance collaboration with administrators, teachers, and parents in carrying out school-based interventions towards sustainability. Further research is also needed regarding the influence of the different school catering business models on food waste.

5.1.1 The role of school principals in building sustainable schools

More precisely, as an immediate avenue of research, I plan to do a study on the relationship between school´s curricular perspective on sustainability, their top management`s profile and their interest in minimizing canteen food waste and putting forth sustainable policies in general. As a follow up of

the third study of my thesis, I would like to get deeper on the analysis of motives related to the willingness of school principals to apply potential food waste minimization initiatives. Through this research, I aim to cluster schools based on their vision on sustainability in general as well as on their policies regarding food waste with the final goal of understanding which interventions would be more easily adopted by each of the clusters.

Schools have been identified as being in a primary position to offer education on nutrition and sustainability, being able to influence present and future consumption patterns. Their role is crucial as food consumption patterns heavily affect the sustainability of the global food supply chain (Benvenuti et al., 2016). Moreover, education for Sustainable Development (ESD) has been considered a priority by global organizations such as UNESCO (UNESCO, 2005), aiming to enable people to address present and future global challenges in a constructive and creative way, and to create more sustainable societies, focusing on key issues such as climate change and sustainable lifestyles, among others. As stated by UNESCO`s former General Manager, Mr. Matsuura, *"education is one of the most powerful instruments we have for bringing about the changes required to achieve sustainable development*" (UNESCO, 2005, p. 3). Closely related to ESD is the concept of sustainable schools where principles and values of sustainability are translated into curriculum and pedagogical practices, embedded in school culture and the resource usage (Kadji-Beltran, Zachariou, & Stevenson, 2013). Therefore, a holistic approach to sustainability characterises a sustainable school, encompassing not only pedagogical issues but also school governance and the management of resources (Henderson, K and Tilbury, 2004). Waste management, closely related to resource management, should therefore be included in the promotion of sustainable school policies.

Nonetheless, school leaders` willingness to address sustainability issues strongly depends upon perceptions of its relative importance. Moreover, those who make it a priority usually feel passionately about it, however, once involved, some oftentimes argue time limitations due to workload considerations and other priorities (Campbell, 2010). This fact may lead to a mismatch between schools' verbal acknowledgement of the importance of sustainability and what they actually do, as noted by Jackson (2006).

The objectives of this study will be:

1) To cluster Spanish primary and secondary schools based in their principal`s attitude towards sustainability in general and food waste in particular, in order to be able to prioritize food waste reduction interventions based on their potential applicability.
2) To explore the role that different institutions and players have in the food waste generation process (school managers, teachers, students, parents, catering staff, etc.)
3) To prioritize food waste reduction initiatives based on their potential acceptability by schools.

APPENDIX A

CHAPTER 2 SAMPLE CHARACTERISTICS

The following table shows the sample characteristics of the study in Chapter 2, which includes nine food service an two bakery corporations, a food bank as well as a fresh food wholesaler and an industrial association.

Interview Code	Position in the Company	Type of Company	Characteristics	Revenue in Spain/ Outlet Number
A1.1	Communication and External Relations Director	Non-commercial Food Service	Food Service for companies, institutions, hospitals, schools, universities, etc.	207 M €
A1.2	Operational Excellence Spain Project Leader			
A1.3	Brand Manager and Strategy Support			
A2	CEO	Non-commercial Food Service	Food Service for companies, institutions, hospitals, schools, universities, etc.	55 M €
A3	Marketing Director	Non-commercial Food Service	Food Service for companies, institutions, hospitals, schools, universities, etc.	150 M €
A4	CEO	Commercial Food Service	Fast food restaurant chain (Burgers)	15 M €/65 outlets
A5	Master Franchise	Commercial Food Service	Fast food restaurant chain	160 M €
A6	Quality control manager	Commercial Food Service	Restaurants at airports, train stations and Highways	410 M €/1000 outlets
A7	CEO	Travel Retail and Food Service	Catering on board trains	109 M €
A8.1	External Communication Director	Wholesaler	Public Company Wholesaler	26.5 M €
A8.2	Communication assistant			
A9	CEO	Commercial Food Service	Restaurants at airports, train stations and Highways	9,000 M €
A10	CEO	Catering and retailing	Food Retail/Catering	40 M €
D2	Commercial Director	Industrial Bakery	Bakery Producer	360 M€
D3	CEO	Industrial Bakery	Frozen Dough Producer	50 M €
M1	Vice-President	NGO	Food Bank	
M2	Food waste Project Manager	Not for profit international organization	Over 25,000 member companies from both supplier and retailer sectors	

APPENDIX B

CHAPTER 3 & 4 SAMPLE CHARACTERISTICS

This Table details the sample characteristics of the qualitative study explained in chapters 3 $ 4. The sample includes twelve managers from nine different institutions and collectives that play a role in school meals.

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	C1.1 Marketing Manager C1.2 Opex Manager C1.3 Social Responsibility Manager
C2	Food service	Headquarters in Spain, operates regionally (Barcelona only)	C2.1 Sales Managers C2.2 Purchasing Manager
C3	Food service	Headquarters in the UK. 17,000 million pounds in 50 countries (group)	C3 Regional Sales Manager
C4	Food service	14,329 billion USD revenue 270,000 employees in 21 countries. Headquarters in the US	C4 Regional Sales Manager
C5	Elementary & Secondary School	1,500 pupils eat daily 2 dining rooms and two service lines	C5.1 Canteen manager C5.2 Cook C5.3 a & b: 2 kitchen assistants C5.4 a to c: 3 caretakers C5.5 a to e: 5 pupils
C6	Private Elementary & Secondary School	1,500 pupils eat daily Seven dining rooms and 4 service lines Compost facilities	C6.1 Canteen manager C6.2a & 2b supervisors C6.3 a to d: 4 pupils
C7	Private Elementary & Secondary School	670 daily diners	C7.1 Canteen coordinator C7.2 Cook
C8	Public Elementary School	250 daily diners Pupils are served at their table	C8 Canteen coordinator
C9	Public Elementary & Secondary School		C9 Canteen coordinator

APPENDIX C

CHAPTER 3 SELF-AUDITING TOOL

As an outcome of our second study a Self-assessment tool resulted. The tool is presented in this Appendix.

A. Record the number of planned meals and the real number of diners				
	Planned number of diners	Actual Diners	% Deviation	Deviation causes
1st shift				E.g. excursions, sick kids,...
2nd shift				
Allergenic menus				
Diet menus				

B.1 Selective weight by stage of the process			
PANTRY LOSS (Out of date and damaged food):			**BIN #1**
1. TOTAL KILOS (Approx.): ..... Kg			
1.b TOTAL POTENTIALLY AVOIDABLE KILOS (Estimate) ..... **Kg**			
FOOD TYPE	WEIGH % on total (% Approx.)	PLACE WHERE IT OCCURRED	CAUSE
E.G.: fruit, bread...		e.g. pantry, fridge...	
COOKING LOSS (Kitchen Waste):			
2. TOTAL KILOS (Approx.): ..... Kg			
2.a UNAVOIDABLE WASTE:			**BIN#2**
E.G. potato peels, egg shells, etc.: ..... Kg			
2.b POTENTIALLY AVOIDABLE WASTE: Cooked but not served, burnt, damaged, etc. (indicate type)			**BIN#3**
			..... % Approx.
FOOD TYPE	WEIGH % on total (% Approx.)	PLACE WHERE IT WAS PRODUCED	CAUSE
		E.g.while cooking, already cooked	E.g.burnt food; less dinners than expected,..
PREPARED FOOD SURPLUS (Display):			**BIN#4**
3. TOTAL KILOS (Approx.): ..... Kg			
3.b TOTAL POTENTIALLY AVOIDABLE KILOS (Estimate) ..... **Kg**			
Record cooked food that is not served			
FOOD TYPE	Quantity (kilos)	Cause	Most probable end (disposal or use)
E.g. Roasted chicken			E.g. Staff meals, soup, donations, etc.

B.2 Selective weight by stage of the process

PLATE WASTE:

4. TOTAL KILOS (Approx.): ..... Kg

4.a UNAVOIDABLE WASTE e.g. Banana peels, bones, ...:	**BIN#5**	Grams / STUDENT
4.b POTENTIALLY AVOIDABLE WASTE	**BIN#6** .....Kg	Grams / STUDENT

FOOD TYPE	WEIGH % on total (% Approx.)	KG		
E.g. Vegetables, legumes, etc.				

C.- Waste Economic Cost

TOTAL KILOS WASTED (1+2+3+4)	
TOTAL AVOIDABLE KILOS (1b+2b+3b+4b)	
C.1 Average per pupil	
C.2 Average weight of meal served per tray (g)	
% waste on food served (C.2 / C.1)	
Average cost/meal (including preparation cost) (€)	
Equivalent of meals thrown away (Total food waste kilos / weight of meal)	
Cost of food waste (€) (Equivalent meals thrown away * average cost per meal)	

D. Waste Destination

How it was discarded	KG	Approximate % on total weigh
Garbage Bin		
Reuse (Mention for what purpose)		
Compost		

REFERENCES

Adams, M. A., Pelletier, R. L., Zive, M. M., & Sallis, J. F. (2005). Salad bars and fruit and vegetable consumption in elementary schools: a plate waste study. *Journal of the American Dietetic Association*, *105*(11), 1789–92. http://doi.org/10.1016/j.jada.2005.08.013

Aschemann-Witzel, J., de Hooge, I., Amani, P., Bech-Larsen, T., & Oostindjer, M. (2015). Consumer-Related Food Waste: Causes and Potential for Action. *Sustainability*, *7*(6), 6457–6477. http://doi.org/10.3390/su7066457

Bansal, Pratima; Roth, K. (2000). Why Companies Go Green : Responsiveness. *Academy of Management*, *43*(4), 717–736. http://doi.org/10.2307/1556363

Bansal, P., & Roth, K. (2000). Why companies go green: a model of ecological responsiveness. *Academy of Management Journal*, *43*(4), 717–736. http://doi.org/10.2307/1556363

Belot, M., & James, J. (2011). Healthy school meals and educational outcomes. *Journal of Health Economics*, *30*(3), 489–504. http://doi.org/10.1016/j.jhealeco.2011.02.003

Belz, F. M. (2006, May). Marketing in the 21st century. *Business Strategy and the Environment*, *15*(3), 139–144. http://doi.org/10.1002/bse.529

Bender, W. H. (1994). Seventh annual hunger research briefing and exchange. *Food Policy*, *19*(5), 483–485. http://doi.org/10.1016/0306-9192(94)90026-4

Benvenuti, L., De Santis, A., Santesarti, F., & Tocca, L. (2016). An optimal plan for food consumption with minimal environmental impact: the case of school lunch menus. *Journal of Cleaner Production*, *129*, 704–713. http://doi.org/10.1016/j.jclepro.2016.03.051

Beretta, C., Stoessel, F., Baier, U., & Hellweg, S. (2013). Quantifying food losses and the potential for reduction in Switzerland. *Waste Management*, *33*(3), 764–773. http://doi.org/10.1016/j.wasman.2012.11.007

Bergman, E., Buergel, N., Englund, T., & Femrite, A. (2004). *Relationships of Meal and Recess Schedules to Plate Waste in Elementary Schools*. The Journal of child Nutrition and Management.

Bernstad Saraiva Schott, A., & Cánovas, A. (2015). Current practice, challenges and potential methodological improvements in environmental evaluations of food waste prevention – A discussion paper. *Resources, Conservation and Recycling*, *101*, 132–142. http://doi.org/10.1016/j.resconrec.2015.05.004

Betz, A., Buchli, J., Göbel, C., & Müller, C. (2015). Food waste in the Swiss food service industry - Magnitude and potential for reduction. *Waste Management (New York, N.Y.)*, *35*, 218–26. http://doi.org/10.1016/j.wasman.2014.09.015

Binyon, S. (2007). Reducing and managing waste in the food industry: food industry sustainability best practice workshop. *London, UK: Food and Drinks Federation*.

Birne, G. (2010). Less Food Waste More Profit. Retrieved from http://www.foodwaste.ie/web-images/Food-Waste-Prevention-Guide.pdf

Bogdan, R., & Biklen, S. (1997). Qualitative research for education. Retrieved from http://n.ereserve.fiu.edu/010013009-1.pdf

Bradley, L. (2011). Food Service/Cafeteria Waste Reduction.

Brundtland, G. H. (1987). Our Common Future: Report of the World Commission on Environment and Development. *Medicine, Conflict and Survival*, *4*(1), 300. http://doi.org/10.1080/07488008808408783

Buzby, J. C., & Guthrie, J. F. (2002). Plate Waste in School Nutrition Programs Final Report to Congress.

Buzby, J. C., & Hyman, J. (2012). Total and per capita value of food loss in the United States. *Food Policy*, *37*(5), 561–570. http://doi.org/10.1016/j.foodpol.2012.06.002

Byker, C. J., Farris, A. R., Marcenelle, M., Davis, G. C., & Serrano, E. L. (2014). Food Waste in a School Nutrition Program After Implementation of New Lunch Program Guidelines. *Journal of Nutrition Education and Behavior*. http://doi.org/10.1016/j.jneb.2014.03.009

Campbell, P. (2010). *Agaisnt the Tide: Challenges of Leading a Sustainable School*. *National college for leadership of schools and children`s services*.

Canali, M., Östergre, K., & Amani, P. (2014). *Drivers of current food waste generation , threats of future increase and opportunities for reduction*.

Chabowski, B. R., Mena, J. A., & Gonzalez-Padron, T. L. (2011). The structure of sustainability research in marketing, 1958–2008: a basis for future research opportunities. *Journal of the Academy of Marketing Science*, *39*(1), 55–70. http://doi.org/10.1007/s11747-010-0212-7

Charlebois, S., Creedy, A., & von Massow, M. (2015). "Back of house" – focused study on food waste in fine dining: the case of Delish restaurants. *International Journal of Culture, Tourism and Hospitality Research*, *9*(3), 278–291. http://doi.org/10.1108/IJCTHR-12-2014-0100

Clarke, C., Schweitzer, Z., & Roto, A. (2015). Reducing Food Waste : Recommendations to the 2015 Dietary Guidelines Advisory Committee, 1–9.

Cohen, J. F. W., Richardson, S. A., Cluggish, S. A., Parker, E., Catalano, P. J., & Rimm, E. B. (2015). Effects of Choice Architecture and Chef-Enhanced Meals on the Selection and Consumption of Healthier School Foods. *JAMA Pediatrics*, *169*(5), 431. http://doi.org/10.1001/jamapediatrics.2014.3805

Cohen, J. F. W., Richardson, S., Austin, S. B., Economos, C. D., & Rimm, E. B. (2013). School lunch waste among middle school students: Nutrients consumed and costs. *American Journal of Preventive Medicine*. http://doi.org/10.1016/j.amepre.2012.09.060

Collison, R., & Colwill, J. S. (1987). Food waste in public houses and restaurants and customer attitudes. *International Journal of Hospitality Management*, *6*(3), 163–167. http://doi.org/10.1016/0278-4319(87)90050-8

Comstock, E. (1979). Plate Waste in School Feeding Progams. *USDA*, (December 1979).

Cooke, L. J., Chambers, L. C., Añez, E. V., & Wardle, J. (2011). Facilitating or undermining? The effect of reward on food acceptance. A narrative review. *Appetite*, *57*(2), 493–497. http://doi.org/10.1016/j.appet.2011.06.016

Creedon, M., Cunningham, D., & Hogan, J. (2010). *Less Food Waste More Profit*.

Creswell, J. W. (2015). *A concise introduction to mixed methods research*.

Dehghan, M., Akhtar-Danesh, N., Merchant, A. T., Nicklas, T., T., B., K.W., C., … T, K. (2005). Childhood obesity, prevalence and prevention. *Nutrition Journal*, *4*(1), 24. http://doi.org/10.1186/1475-2891-4-24

Derqui, B., Fayos, T., & Fernandez, V. (2016). Towards a More Sustainable Food Supply Chain: Opening up Invisible Waste in Food Service. *Sustainability*, *8*(7), 693. http://doi.org/10.3390/su8070693

DeSimone, L. D., Popoff, F., & World Business Council for Sustainable Development. (2000). *Eco-*

efficiency : the business link to sustainable development. MIT Press.

Dillon, M. S., & Lane, H. W. (1989). Evaluation of the offer vs. serve option within self-serve, choice menu lunch program at the elementary school level. *Journal of the American Dietetic Association*, *89*(12), 1780–1785.

Doherty, A. (2009). Market and partner selection processes in international retail franchising. *Journal of Business Research*.

Dyllick, T., Hockerts, K., & Thomas Dyllick, K. H. (2002). Beyond the business case for corporate sustainability. *Business Strategy and the Environment*, *11*(2), 130–141. http://doi.org/10.1002/bse.323

Eklington, J. (1998). *Cannibals with Forks: The Triple Bottom Line of the 21st century.* New Society Publishers.

Engström, R., & Carlsson-Kanyama, A. (2004). Food losses in food service institutions Examples from Sweden. *Food Policy*, *29*(3), 203–213. http://doi.org/10.1016/j.foodpol.2004.03.004

EPA. (2014). *A guide to conducting and Analyzing a Food Waste Assessment*.

Estudios Consultas, I., & González Vaqué, L. (2015). El Insostenible Desperdicio De Alimentos: ¿Qué Podemos Hacer Los Consumidores?

European Commission. (2010). *Preparatory Study on Food Waste Across Eu 27*. *October* (Vol. 33). http://doi.org/10.2779/85947

European Union Committee. (2014). Counting the Cost of Food Waste: EU Food Waste Prevention. *Authority of the House of Lords*, (April), 78.

Evaluando la aceptación de alimentos en escolares; registro visual cualitativo frente a análisis de residuos de alimentos.

EWWR. (2014). Do you dare to be aware?

Falasconi, L., Vittuari, M., Politano, A., & Segrè, A. (2015). Food Waste in School Catering: An Italian Case Study. *Sustainability*, *7*(11), 14745–14760. http://doi.org/10.3390/su71114745

FAO. (2009). How to Feed the World in 2050. *Insights from an Expert Meeting at FAO*, *2050*(1), 1–35. http://doi.org/10.1111/j.1728-4457.2009.00312.x

FAO. (2011). *Global food losses and food waste: extent, causes and prevention*. *Save Food!* Retrieved from http://www.fao.org/fileadmin/user_upload/ags/publications/GFL_web.pdf

FAO. (2013). *Food wastage footprint. Impacts on natural resources. Summary Report*. *Food wastage footprint Impacts on natural resources*. http://doi.org/ISBN 978-92-5-107752-8

FAO. (2015). *The State of Food Insecurity in the World: Meeting the 2015 international hunger targets: taking stock of uneven progress*. *FAO, IFAD and WFP*. http://doi.org/I4646E/1/05.15

Ferreira, M., Martins, M. L., & Rocha, A. (2013). Food waste as an index of foodservice quality. *British Food Journal*, *115*(11), 1628–1637. http://doi.org/10.1108/BFJ-03-2012-0051

Finn, S. M. (2014). Valuing our food: minimizing waste and optimizing resources. *Zygon®*, *49*(4), 992–1008. http://doi.org/10.1111/zygo.12131

Garnett, T. (2008). Cooking up a storm and our changing climate. *Strategy*, (September), 156.

Garrone, P., & Melacini, M. (2012). Food Waste Reduction: Empirical Findings from the Italian Food Supply Chain. *Available at SSRN.*

Garrone, P., Melacini, M., & Perego, A. (2014). Opening the black box of food waste reduction. *Food Policy*, *46*, 129–139. http://doi.org/10.1016/j.foodpol.2014.03.014

Gerbens-Leenes, P. W., Moll, H. C., & Schoot Uiterkamp, A. J. M. (2003). Design and development

of a measuring method for environmental sustainability in food production systems. *Ecological Economics*, *46*(2), 231–248. http://doi.org/10.1016/S0921-8009(03)00140-X

Getlinger, Mary Jane;Laughlin, Carol V T;Bell, Elizabeth;Akre, Christine;Arjmandi, B. H. (1996). Food waste is reduced when elementary-school children have recess before lunch - ProQuest.

Gjerris, M., & Gaiani, S. (2013). Household food waste in Nordic countries: Estimations and ethical implications. *Etikk I Praksis-Nordic Journal of Applied Ethics*.

Göbel, C., Langen, N., Blumenthal, A., Teitscheid, P., & Ritter, G. (2015). Cutting Food Waste through Cooperation along the Food Supply Chain. *Sustainability*, *7*, 1429–1445. http://doi.org/10.3390/su7021429

Godfray, H. C. J., Crute, I. R., Haddad, L., Lawrence, D., Muir, J. F., Nisbett, N., … Whiteley, R. (2010). The future of the global food system. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *365*(1554), 2769–2777. http://doi.org/10.1098/rstb.2010.0180

Godfray, Beddington, J. R., Crute, I. R., Haddad, L., Lawrence, D., Muir, J. F., … Toulmin, C. (2010). Food security: the challenge of feeding 9 billion people. *Science (New York, N.Y.)*, *327*(5967), 812–8. http://doi.org/10.1126/science.1185383

Goggins, G., & Rau, H. (2015). Beyond calorie counting: assessing the sustainability of food provided for public consumption. *Journal of Cleaner Production*, *112*, 257–266. http://doi.org/10.1016/j.jclepro.2015.06.035

Goonan, S., Mirosa, M., & Spence, H. (2014). Getting a taste for food waste: A mixed methods ethnographic study into hospital food waste before patient consumption conducted at three new zealand foodservice facilities. *Journal of the Academy of Nutrition and Dietetics*, *114*(1), 63–71. http://doi.org/10.1016/j.jand.2013.09.022

Griffin, M., Sobal, J., & Lyson, T. (2009). An analysis of a community food waste stream. *Agriculture and Human Values*. Retrieved from http://link.springer.com/article/10.1007/s10460-008-9178-1

Grimm, J. H., Hofstetter, J. S., & Sarkis, J. (2014). Critical factors for sub-supplier management: A sustainable food supply chains perspective. *International Journal of Production Economics*, *152*, 159–173. http://doi.org/10.1016/j.ijpe.2013.12.011

Gunasekera, D. (2015). Cut food waste to help feed world. *Nature*.

Gunders, D. (2012). Wasted: How America is losing up to 40 percent of its food from farm to fork to landfill. *NRDC Issue Paper*, (August), 1–26. http://doi.org/12-06-B

Gustavsson, J., & Stage, J. (2011). Retail waste of horticultural products in Sweden. *Resources, Conservation and Recycling*, *55*(5), 554–556. http://doi.org/10.1016/j.resconrec.2011.01.007

Guthrie, J. F., & Buzby, J. C. (2002). Several Strategies May Lower Plate Waste in School Feeding Programs. *Food Review*, *25*(2), 36.

Hafner, G., Barabosz, J., Schneider, F., Scherhaufer, S., Schuller, H., & Leverenz, D. (2012). Vorschläge zur Verminderung der Wegwerfrate bei Lebensmitteln in Deutschland - Kurzfassung -.

Hall, TJ; Slaper, T. (2011). The triple bottom line: what is it and how does it work? *Indiana Business Review*.

Halloran, A., Clement, J., Kornum, N., Bucatariu, C., & Magid, J. (2014). Addressing food waste reduction in Denmark. *Food Policy*, *49*. http://doi.org/10.1016/j.foodpol.2014.09.005

Hanson, C., Lipinski, B., Robertson, Kai; Dias, D., & Gavilan, I. (2016). *FLW Protocol Steering Committee and Authors Other Contributing Authors*. *Food and Agriculture Organization of the United Nations*.

Hanson, C., Lipinsky, B., Robertson, K., Dias, D., Gavilan, I., Greverath, P., … Somogyi, D. (2016).

Food Loss and Waste Accounting and Reporting Standard. Version 1.0. Executive Summary.

Harik, R., EL Hachem, W., Medini, K., & Bernard, A. (2015). Towards a holistic sustainability index for measuring sustainability of manufacturing companies. *International Journal of Production Research*, *53*(July), 1–23. http://doi.org/10.1080/00207543.2014.993773

Hassini, E., Surti, C., & Searcy, C. (2012). A literature review and a case study of sustainable supply chains with a focus on metrics. *International Journal of Production Economics*, *140*(1), 69–82. http://doi.org/10.1016/j.ijpe.2012.01.042

Heller, M. C., & Keoleian, G. A. (2003). Assessing the sustainability of the US food system: A life cycle perspective. *Agricultural Systems*, *76*(3), 1007–1041. http://doi.org/10.1016/S0308-521X(02)00027-6

Henderson, K and Tilbury, D. (2004). *Whole-school approaches to sustainability: An international review of whole- school sustainability programs*.

HLPE. (2014). Las pérdidas y el desperdicio de alimentos en el contexto de sistemas alimentarios sostenibles. *Comite de Seguridad Alimentaria Mundial*. Retrieved from http://www.fao.org/3/a-i3901s.pdf

Hogg, D., & Barth, J. (2007). Dealing with Food Waste in the UK. *Report for WRAP.*

Hult, G. T. M. (2010). Market-focused sustainability: market orientation plus! *Journal of the Academy of Marketing Science*, *39*(1), 1–6. http://doi.org/10.1007/s11747-010-0223-4

Jacko,Dellava,Ensle, & Hoffman. (2007). Use of the Plate waste. *Journal of Extension*. Retrieved from http://www.joe.org/joe/2007december/rb7.php

Jackson, L. (2006). Leading sustainable schools : what the research tells us. *National College for School Leadership*. Retrieved from www.ncsl.org.uk

Jurgenson, Á. (2005). Cómo hacer investigación cualitativa. Ecuador: reimp. *Paidos. Pag*.

Just, D. R., & Price, J. (2013). Using Incentives to Encourage Healthy Eating in Children. *Journal of Human Resources*, *48*(October 2012), 855–872. http://doi.org/10.1353/jhr.2013.0029

Kadji-Beltran, C., Zachariou, A., & Stevenson, R. B. (2013). Leading sustainable schools: exploring the role of primary school principals. *Environmental Education Research*, *19*(3), 303–323. http://doi.org/10.1080/13504622.2012.692770

Kim, K., & Morawski, S. (2012). Quantifying the Impact of Going Trayless in a University Dining Hall. *Journal of Hunger & Environmental Nutrition*, *7*(4), 482–486. http://doi.org/10.1080/19320248.2012.732918

Kiron, D; Kruschwiths, N; Haanes, Knut;Reeves, M; Kell, G. (2015). Joining Forces Collaboration and Leadership for Sustainability. *MIT Sloan Management Review*.

Kleindorfer, P. (2005). Sustainable Operations Management, *14*(4), 482–492. http://doi.org/10.1007/978-3-319-14002-5

Kopnina, H. (2015). Sustainability: new strategic thinking for business. *Environment, Development and Sustainability*. http://doi.org/10.1007/s10668-015-9723-1

Kotler, P. (2011). Reinventing Marketing to Manage the Environmental Imperative. *Journal of Marketing*, *75*(4), 132–135. http://doi.org/10.1509/jmkg.75.4.132

Kummu, M., de Moel, H., Porkka, M., Siebert, S., Varis, O., & Ward, P. J. (2012). Lost food, wasted resources: Global food supply chain losses and their impacts on freshwater, cropland, and fertiliser use. *Science of The Total Environment*, *438*, 477–489. http://doi.org/10.1016/j.scitotenv.2012.08.092

Lebersorger, S., & Schneider, F. (2011). Discussion on the methodology for determining food waste

in household waste composition studies. *Waste Management*, *31*(9–10), 1924–1933. http://doi.org/10.1016/j.wasman.2011.05.023

Lipinski, B., Hanson, C., Lomax, J., Kitinoja, L., Waite, R., & Searchinger, T. (2013). Reducing Food Loss and Waste. *World Resource Institute*, (June), 1–40.

Lubin, D. A., & Esty, D. C. (2010). The sustainability imperative. *Harvard Business Review*, *88*(5). http://doi.org/10.1057/palgrave.crr.1540128

Lundqvist, J., Fraiture, C. de, & Molden, D. (2008). Saving water: from field to fork: curbing losses and wastage in the food chain.

Marlette, M. A., Templeton, S. B., & Panemangalore, M. (2005). Food Type, Food Preparation and competitive food purchases impact school lunch plate waste by sixth-grade students. *Journal of the American Dietetic Association*, *105*(11), 1779–1782. http://doi.org/10.1016/j.jada.2005.08.033

Mathijs, E. (2012). Sustainable Food Consumption and Production in a Resource-constrained World, 4.

Mena, C., Adenso-Diaz, B., & Yurt, O. (2011a). The causes of food waste in the supplier-retailer interface: Evidences from the UK and Spain. *Resources, Conservation and Recycling*, *55*(6), 648–658. http://doi.org/10.1016/j.resconrec.2010.09.006

Mikkola, M. (2009). Shaping professional identity for sustainability. Evidence in Finnish public catering. *Appetite*, *53*(1), 56–65. http://doi.org/10.1016/j.appet.2009.05.007

Miles, M., & Huberman, A. (1994). Qualitative data analysis: An expanded sourcebook.

Ministerio de Educación Cultura y Deporte. (2015). Base Estadísticas Educación.

Mirosa, M., Munro, H., Mangan-Walker, E., & Pearson, D. (2016). Reducing waste of food left on plates: interventions based on means-end chain analysis of customers in foodservice sector. *British Food Journal*, *118*(9).

Nellemann, C. (2009a). The environmental food crisis: the environment's role in averting future food crises: a UNEP rapid response assessment.

Nellemann, C. (2009b). The environmental food crisis: the environment's role in averting future food crises: a UNEP rapid response assessment.

Niaki, S. F., Moore, C. E., Chen, T.-A., & Weber Cullen, K. (2017). Younger Elementary School Students Waste More School Lunch Foods than Older Elementary School Students. *Journal of the Academy of Nutrition and Dietetics*, *117*(1), 95–101. http://doi.org/10.1016/j.jand.2016.08.005

Östergren, K., Jenny Gustavsson, Bos-Brouwers, H., Timmermans, T., Hansen, J., Møller, H., … Redlingshöfer, B. (2014). *FUSIONS definitional framework for food waste. Full report*.

Papargyropoulou, E., Lozano, R., K. Steinberger, J., Wright, N., & Ujang, Z. Bin. (2014). The food waste hierarchy as a framework for the management of food surplus and food waste. *Journal of Cleaner Production*, *76*, 106–115. http://doi.org/10.1016/j.jclepro.2014.04.020

Parfitt, J., Barthel, M., & Macnaughton, S. (2010). Food waste within food supply chains: quantification and potential for change to 2050. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, *365*(1554), 3065–81. http://doi.org/10.1098/rstb.2010.0126

Perseo. (2008). Guía de comedores escolares: programa PERSEO. *Ministerio de Sanidad Y Consumo*. Retrieved from http://www.vnutritionconsulting.com/files/guia comedores escolares_ programa perseo.pdf

Pirani, S. I., & Arafat, H. A. (2015). Reduction of Food Waste Generation in the Hospitality Industry. *Journal of Cleaner Production*. http://doi.org/10.1016/j.jclepro.2015.07.146

Pratt, M. (2009). From the editors: For the lack of a boilerplate: Tips on writing up (and reviewing)

qualitative research. *Academy of Management Journal*.

Priefer, C., Jörissen, J., & Bräutigam, K. R. (2016). Food waste prevention in Europe - A cause-driven approach to identify the most relevant leverage points for action. *Resources, Conservation and Recycling*, *109*, 155–165. http://doi.org/10.1016/j.resconrec.2016.03.004

Principato, L., Secondi, L., & Pratesi, C. A. (2015). Reducing food waste: an investigation on the behaviour of Italian youths. *British Food Journal*, *117*(2), 731–748. http://doi.org/10.1108/BFJ-10-2013-0314

Reger, C., O´Neil, C. E., Nicklas, T. A., Myers, L., & Berenson, G. (1996). Plate waste of school lunches served to children in a low-socioeconomic elementary school in south Louisiana [1996]. *National Agricultural Library, Information Systems Division*, 1–4.

Rickinson, M., Hall, M., & Reid, A. (2016). Sustainable schools programmes: what influence on schools and how do we know? *Environmental Education Research*, *22*(3), 360–389. http://doi.org/10.1080/13504622.2015.1077505

Rodriguez Tadeo, A., Patiño Villena, B., Periago Caston, M. J., Ros Berruezo, G., Gonzalez Martinez Lacuesta, E., Alejandra, R. T., … Eduardo, G. M. L. (2014). Evaluando la aceptacion de alimentos en escolares; registro visual cualitativo frente a analisis de residuos de alimentos. *Nutricion Hospitalaria*, *29*(5), 1054–1061. http://doi.org/10.3305/nh.2014.29.5.7340

School Food Trust. (2009). A fresh look at the school meal experience second edition.

Schrettle, S., Hinz, A., Scherrer-Rathje, M., & Friedli, T. (2014). Turning sustainability into action: Explaining firms' sustainability efforts and their impact on firm performance. *International Journal of Production Economics*, *147*(PART A). http://doi.org/10.1016/j.ijpe.2013.02.030

Seuring, S., & Gold, S. (2013). Sustainability management beyond corporate boundaries: From stakeholders to performance. *Journal of Cleaner Production*, *56*, 1–6. http://doi.org/10.1016/j.jclepro.2012.11.033

Silvennoinen, K., Katajajuuri, J. M., Hartikainen, H., Jalkanen, L., Koivupuro, H. K., & Reinikainen, A. A. (2012). Food waste volume and composition in the finnish supply chain: special focus on food service sector. *Proceedings Venice*, 12–15.

Silverman, D. (2015). *Interpreting qualitative data*.

Slawson, D. L., Southerland, J., Lowe, E. F., Dalton, W. T., Pfortmiller, D. T., & Schetzina, K. (2013). Go Slow Whoa Meal Patterns: Cafeteria Staff and Teacher Perceptions of Effectiveness in Winning With Wellness Schools. *Journal of School Health*, *83*(7), 485–492. http://doi.org/10.1111/josh.12056

Smil, V. (2001). *Feeding the World: A Challenge for the Twenty-First Century*.

Smith, N. C. (2009). Bounded goodness: marketing implications of Drucker on corporate responsibility. *Journal of the Academy of Marketing Science*, *37*(1), 73–84. http://doi.org/10.1007/s11747-008-0110-4

Smith, S. L., & Cunningham-Sabo, L. (2014). Food choice, plate waste and nutrient intake of elementary- and middle-school students participating in the US National School Lunch Program. *Public Health Nutrition*, *17*(6), 1255–63. http://doi.org/10.1017/S1368980013001894

Society, O. M. (2005). Sustainable Operations Management, *14*(4), 482–492. http://doi.org/10.1007/978-3-319-14002-5

Sonnino, R., & McWilliam, S. (2011). Food waste, catering practices and public procurement: A case study of hospital food systems in Wales. *Food Policy*, *36*(6), 823–829. http://doi.org/10.1016/j.foodpol.2011.09.003

Storcksdieck genannt Bonsmann, S. (2014). Comprehensive mapping of national school food

policies across the European Union plus Norway and Switzerland. *Nutrition Bulletin*, *39*(4), 369–373. http://doi.org/10.1111/nbu.12109

Strasser, S. (2014). *Waste and Want: A Social History of Trash*. Henry Holt and Company.

Stuart, T. (2009). *Waste: Uncovering the Global Food Scandal*. Penguin Books Limited.

Székely, F., & Knirsch, M. (2005). Responsible leadership and corporate social responsibility: Metrics for sustainable performance. *European Management Journal*, *23*(6), 628–647. http://doi.org/10.1016/j.emj.2005.10.009

Thyberg, K. L., & Tonjes, D. J. (2016). Drivers of food waste and their implications for sustainable policy development. *Resources, Conservation and Recycling*, *106*, 110–123. http://doi.org/10.1016/j.resconrec.2015.11.016

Tielens, J., & Candel, J. (2014). Reducing food wastage , improving food security?, *37*.

Tilman, D., Fargione, J., Wolff, B., D'Antonio, C., Dobson, A., Howarth, R., … Swackhamer, D. (2001). Forecasting agriculturally driven global environmental change. *Science (New York, N.Y.)*, *292*(5515), 281–4. http://doi.org/10.1126/science.1057544

U.S. Environmental Protection Agency. (2014). *A Guide to Conducting and Analyzing a Food Waste Assessment* (Vol. 28).

UNESCO. (2005). *UN Decade of Education for Sustainable Development*.

US General Accounting Office. (1996). School Lunch Programs: Role & Impacts of Private Food Service Companies, (August), 62.

Ventour, L. (2008). *The food we waste*. *Wrap* (Vol. 0).

Wansink, B., & van Ittersum, K. (2013). Portion size me: plate-size induced consumption norms and win-win solutions for reducing food intake and waste. *Journal of Experimental Psychology. Applied*, *19*(4), 320–32. http://doi.org/10.1037/a0035053

Warshawsky, D. N. (2015). Food waste, sustainability, and the corporate sector: case study of a US food company. *The Geographical Journal*, n/a-n/a. http://doi.org/10.1111/geoj.12156

Whatley, J., Donnelly, J., Jacobsen, D., Hill, J., & Carlson, M. (1996). Energy and macronutrient consumption of elementary school children served modified lower fat and sodium lunchs or standard higher fat and sodium lunches. *Journal of the American College of Nutrition*, *15*(6), 602–607. http://doi.org/10.1080/07315724.1996.10718636

Wilkie, A. (2015). Food Waste Auditing at Three Florida Schools. *Sustainability (Switzerland)*.

Williams, H., Wikström, F., Otterbring, T., Löfgren, M., & Gustafsson, A. (2012). Reasons for household food waste with special attention to packaging. *Journal of Cleaner Production*, *24*, 141–148. http://doi.org/10.1016/j.jclepro.2011.11.044

Williams, P., & Walton, K. (2011). Plate waste in hospitals and strategies for change. *E-SPEN, the European E-Journal of Clinical Nutrition and Metabolism*, *6*(6), e235–e241. http://doi.org/10.1016/j.eclnm.2011.09.006

Williamson, D. A., Allen, H. R., Martin, P. D., Alfonso, A., Gerald, B., & Hunt, A. (2004). Digital photography: A new method for estimating food intake in cafeteria settings. *Eating and Weight Disorders*, *9*(1), 24–28. http://doi.org/10.1007/BF03325041

World Resources Institute. (2016). *Food Loss and Waste Accounting and Reporting Standard*. *World Resources Institute*.

Wrap. (2011). *Food waste in schools*. Banbury, Oxon.

Yakovleva, N., Sarkis, J., & Sloan, T. (2012). Sustainable benchmarking of supply chains: the case of the food industry. *International Journal of Production Research*, *50*(5), 1297–1317.

http://doi.org/10.1080/00207543.2011.571926

Yano, J., & Sakai, S. (2015). Waste prevention indicators and their implications from a life cycle perspective: a review. *Journal of Material Cycles and Waste Management*, *18*(1), 38–56. http://doi.org/10.1007/s10163-015-0406-7

Yoon, S.-J., & Kim, H.-A. (2012). Elementary School Students' Perception of Food Waste and Factors Affecting Plate Waste Rate of School Foodservice in the Gyeongnam Area. *Journal of the Korean Dietetic Association*, *18*(2), 126–140. http://doi.org/10.14373/JKDA.2012.18.2.126