

# **Food waste prevention in quick service restaurants**

A comparative case study on the quantity, source, cost and cause

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“The greatest threat to our planet is the belief that someone else will save it.”

- Robert Swan OBE

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## **Abstract**

This research aims to fill the knowledge gap with regards to food waste prevention with a specific focus on quick service restaurants (QSRs) – also known as fast food restaurants. Restaurants are in a prime position to reduce food waste produced in the consumptive stages of the food supply chain, and more focus should be placed on how restaurants can help achieve food waste reduction targets. The research takes a comparative case study approach to better understand and identify the quantity, source and cause of food waste in QSRs; the factors that contribute towards QSRs producing more food waste than others; food waste prevention measures; and the financial incentives for food waste prevention.

The research finds that the predominant sources and causes of food waste in the case study QSRs relate to food spoilage in the serving line and customer plate waste due to excessive portion sizes and the eating culture of customers. The research also finds that there can be a large variation between the causes and sources of food waste in QSRs within the same chain, and this can depend on the eating culture of customers and how individual QSRs deal with serving food waste and respond and adapt to food health and safety regulations. The research finds that, when taking into account the full costs of food waste, QSRs producing low amounts of food waste can pay around 3 per cent of their turnover on food waste, while QSRs producing high amounts can pay up to 15 per cent. Reducing food waste also has the added effect of potentially saving up to 30 per cent energy and water consumption associated with preparing, processing and cooking food that's wasted.

In order for restaurants to reduce food waste, the study highlights that there is a general need for QSRs and restaurants to focus more on monitoring, measuring and identifying the source of avoidable food waste; conduct regular full-costing calculations to understand and provide incentives for food waste minimization; and identify ways to legally reuse serving food waste in other menu items as opposed to simply throwing it away.

**Keywords:** Food Waste; Quick Service Restaurants; Prevention.

## Executive Summary

### Introduction and problem definition

Each year, we lose or waste around 30-50 per cent of the edible parts of food that is produced and intended for human consumption globally. Food loss and waste, by its very nature, is extremely inefficient. It has negative environmental, economic and social impacts, including GHG emissions, resource depletion, food insecurity, poverty and economic loss along the entire food supply chain. While source reduction is the preferred approach for addressing the “food waste problem”, policy measures and research regarding food waste in industrialised countries have historically targeted food waste management, as opposed to food waste prevention and source reduction. Over the past few years, however, it appears that the EU and the global community have begun to show more of a commitment towards food waste prevention and source reduction. A number of studies have been published regarding the global extent of food waste and potential food waste reduction measures (including by the UNFAO). In 2011 the European Commission identified food as a key sector where resource efficiency should be improved and set targets to halve the disposal of edible food waste by 2020. In 2012, the European Parliament also issued a resolution to halve food waste by 2025 and designate 2014 as the “European Year Against Food Waste”.

The food services/catering industry produces 14 per cent of food waste in the EU. However, it has not been a central focus area for food waste prevention, with EU countries primarily targeting food waste prevention in households and retail. Further, measures and research about food waste in food services predominantly focus on food waste management (such as composting and anaerobic digestion) as opposed to source reduction. This research aims to fill the knowledge gap with regards to food waste prevention, with a specific focus on quick service restaurants (QSRs) – also known as fast food restaurants. Taking a “top-down” approach, the research seeks to address the following research questions:

- What are the major sources and causes of food waste in QSRs?
- How can QSRs benefit financially by minimizing and preventing on-site food waste?

### Case study methodologies

To respond to the research questions, this research takes a comparative case study approach whereby two “higher performing” restaurants (Europe A and B) are compared against two “lower performing” restaurants (China A and B) within the same QSR chain regarding the amount of food waste they produce. The QSR chain the restaurants belong to is global in nature, and operates over 300 stores. The chain could be further classified as “fast casual restaurants”, which are a category of QSRs but the food and atmosphere are considered a higher quality than traditional QSRs.

The methodology, which was developed through the literature review, involved conducting a material flow analysis (MFA) and Sankey diagrams of food waste in the four restaurants investigated to identify and highlight the major source points of food waste. The MFA was conducted in the higher performing restaurants through a waste audit of one day of operations, where food waste was collected by source, weighed and observed for avoidability. The MFA in the lower performing restaurants was conducted through estimations on quantity, source and avoidability developed through interviews with staff members and onsite observations. “Avoidable” food waste was defined to include all food that was produced and intended for human consumption but is not ultimately consumed by humans – i.e. all food that was originally intended for human consumption but leaves the food supply chain for non-human consumption (including for the production of biogas, compost or energy through

incineration). “Unavoidable” food waste was defined to include inedible by-products that were never intended for human consumption, such as bones, vegetable peelings and eggshells. The factors contributing towards food waste source and quantity were then obtained in all four restaurants through further examination of the results of the MFA, conducting semi-structured interviews with on-site staff members (including food and beverage managers, and kitchen staff), making personal observations, and reviewing company documentation.<sup>1</sup>

The full costs of food waste in one high performing restaurant (Europe A) and the two lower performing restaurants were calculated looking at three parameters: (1) the cost of food purchased and wasted, (2) the cost of processing, preparing and cooking food that is wasted; and (3) the costs of waste disposal. Parameter (1) was based on the actual internal costs recorded by each case study QSR in their Waste Reports (and as a proportion of turnover). Parameter (2) was calculated based on a weight estimation of the proportion of food wasted versus food consumed and applied to total electricity, water and staffing costs. Parameter (3) was calculated based on actual food waste disposal costs paid by the case study QSRs.

## **Quantity, sources and causes of food waste**

The research found that the lower performing restaurants produced 4–10 times more waste in total and 2.5–5 times more waste per customer served than the higher performing restaurants. The difference between the higher and lower performing restaurants was primarily attributable to the large amount of customer plate waste produced in the Chinese restaurants compared to the European restaurants. The higher amount of customer plate waste in the Chinese QSRs was found to be as a result of the eating culture in China whereby consumers prefer to order around 30 per cent more food than they need as a sign of affluence. This in turn resulted in the Chinese QSRs serving much higher portion sizes than in the Europe QSRs (largely made up of excessive amounts of rice).

The higher performing restaurants did however produce a substantial amount of avoidable food waste in the serving line as a result of failing to adapt to forecasting throughout the day and throwing away food that was potentially reusable. There was a variation between the amount of serving food waste produced in Europe A compared to Europe B, and this was assumed to be related to the way in which Europe B finds innovative and original ways of dealing with serving food waste that diverts it away from the food waste stream (i.e. reusing it) while Europe A has a strict approach and generally disposes of all food in the serving line. The Chinese restaurants also produced a substantial amount of pre-consumption food waste, however this was largely classified as unavoidable food waste (likely due to the general nature of Asian cooking compared to western cooking). Like Europe B, the Chinese restaurants also had a system of reusing serving food waste where possible.

## **Food waste costs**

With regards to financial incentives, the research found that the “higher performing” restaurant (Europe A) spends around 3 per cent of daily turnover (or €2.9 per kg) on food waste, while the “lower performing” restaurants (China A and B) spend 10-15 per cent of turnover on food waste. As such, the higher performing restaurant was saving up to 12 per cent of turnover by implementing food waste prevention policies – even though these policies were from a cost-saving as opposed to environmental perspective. The study found however that comparing relative costs between the European and Chinese restaurants was difficult considering the Chinese restaurants generally face lower costs than the European restaurants.

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<sup>1</sup> See the Primary Interviews and Documentation chapter of this thesis for a more detailed list of site visit dates, interviews and documentation reviewed.

Also, the Chinese restaurants did not appear to record all costs of food purchased and wasted in the kitchen, unlike the European restaurants. Finally, the study found that the costs of food waste could be minimal when just looking at the costs of food waste disposal. However, the costs increase substantially when including the estimated costs of processing, preparing and cooking food that is wasted.

## **Conclusions**

Preventing food waste in restaurants and QSRs could have a significant impact on preventing food waste globally. The study shows that the potential for food waste reduction and financial savings is substantial, even in restaurants that are considered “higher performing” when it comes to food waste. This study highlights the importance of addressing food waste in QSRs in storage and serving, and post-consumption food waste generally, as opposed to preparation food waste, which was found to be minimal when compared to ordinary restaurants. To this end, accurate forecasting and planning in QSRs is particularly important to reduce serving food waste. Similarly, serving food waste can be reduced through finding innovative and creative ways to reuse it in other recipes or redistribute to the staff restaurant.

This study also highlights the importance of portion control and sizing to ensure the customer receives correct portion sizing to avoid post-consumption food waste. The Europe A case study demonstrated that food waste could be minimised where portion control is strictly applied and followed. The case studies in China demonstrated that having portion sizes that are too big – even if that is what is culturally desired – could substantially increase the amount of food waste produced on site. Checking the amount and type of food waste produced on customer plates is also an important measure to ensure portion sizes are adequate, and customers are not routinely wasting a certain type of food.

Reducing food waste would naturally have the added flow-on effect of reducing energy and water consumption associated with processing, preparing and cooking food that’s wasted. In the worstcase scenario, it was estimated that preventing avoidable food waste could potentially save up to 30 per cent of these costs.

The wider implications of this study are that QSRs and restaurants generally could focus more on monitoring and measuring avoidable food waste in order to minimize its production; conduct regular full-costing calculations to understand and provide incentives for food waste minimization; and identify ways to legally reuse food in other menu items as opposed to having a blanket policy of always throwing away serving food items.

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## Abbreviations and Measurements

BCFN	Barilla Centre for Food Nutrition
CO <sub>2</sub> e	Carbon dioxide equivalent
m <sup>3</sup>	Cubic metres
Cust	Customer restaurant (in case study)
€	Euro
EC	European Commission
EU	European Union
FSC	Food Supply Chain
g	Grams
£	Great Britain Pound
GHG	Green house gases
Kcal	Kilocalories
Kg	Kilograms
LCT	Life Cycle Thinking
MFA	Material Flow Analysis
NGO	Non-Governmental Organisation
QSR	Quick Service Restaurant
RECP	Resource Efficiency and Cleaner Production
RMB	Renminbi or Chinese Yuán (the official currency of the People's Republic of China)
SRA	Sustainable Restaurant Association
Staff	Staff restaurant (in case study)
t	Tonne
UK	United Kingdom
UNEP	United Nations Environment Programme
UNFAO	United Nations Food and Agriculture Organisation
UNIDO	United Nations Industrial Development Organisation
US EIA	US Energy Information Administration
US EPA	US Environmental Protection Agency
USD	United States Dollar
WRAP	Waste Resources Action Plan
WRI	World Resources Institute

# 1 Introduction

## 1.1 Food waste – a global issue

Food loss and waste is a significant global problem that receives an increasing amount of attention from governments, non-governmental organisations, industry and the media. Each year, we lose or waste around 30-50 per cent of the edible parts of food that is produced and intended for human consumption globally (Gustavsson et al, 2011; Institute of Mechanical Engineers, 2013). When converted to calories, approximately 24 per cent of all calories produced for human consumption (or one out of every four calories) is lost or wasted somewhere along the food supply chain – from farm to fork (Lipinski et al., 2013). That is 1.3-1.5 billion tonnes of food wasted annually that could have been consumed by, and improved the livelihoods of, the impoverished people of the world. Instead, it often ends up in landfills where it rots and produces methane, a potent greenhouse gas.

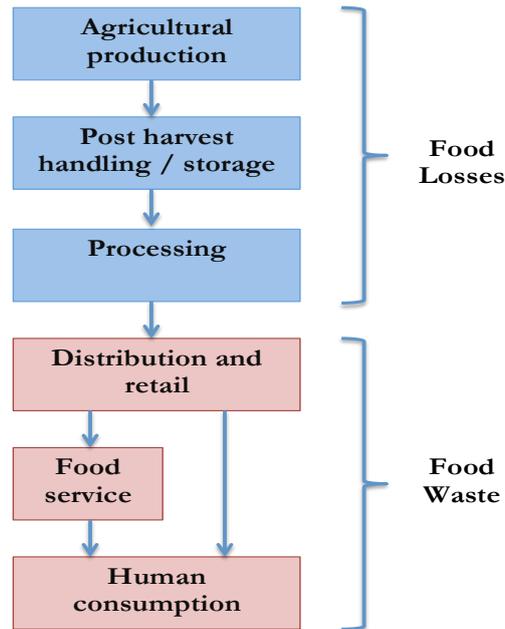
Food loss and waste is, by its very nature, extremely inefficient and has negative environmental, economic and social impacts. From an environmental point of view, when food is lost or wasted, all the resources that have gone into producing the food are wasted too – including water, energy and land (Lundqvist et al, 2008; Pimentel & Pimentel, 2003; Institute for Mechanical Engineers, 2013). The United Nations Environment Programme (UNEP) estimates that global food production occupies 25 per cent of all habitable land, is responsible for 70 per cent of freshwater consumption and 80 per cent of deforestation, and is the single largest driver of biodiversity loss and land-use change in the world (UNEP, 2013). If estimates are right, 30-50 per cent of this resource use can be attributed to food loss and waste. Further, food loss and waste contributes significantly towards global GHG emissions through the production of methane from the digestion of organic waste in landfills and, more significantly, the embedded emissions associated with the production, processing, transport and retailing of food that has been lost or wasted (Garnett, 2008). Around 4.2 tonnes of CO<sub>2</sub>e emissions are produced for each tonne of food waste disposed of, including around 0.5 tonnes produced through landfill disposal (WRAP, 2010; WRAP; 2012). In industrialised countries, growing food that is ultimately wasted has been estimated to account for 10 per cent of GHG emissions (Stuart, 2009).

Food loss and waste also results in financial loss for local farmers, manufacturers, food processors and retailers, which can in turn drive up the price of food for the consumers. This loss comes from not only losing income through sales, but also losing the money and resources spent on processing, preparing and cooking the food along the way. For example, retailers often refuse to purchase perfectly edible fruit and vegetables from farmers because they are not aesthetically pleasing or uniform in size and shape. This food then needs to be disposed of at a financial loss to the farmers who produced it. Food loss and waste also presents a serious social problem and contributes substantially towards food insecurity, particularly in developing countries where people do not have access to enough food currently – let alone in the future. It has been estimated that the global community needs to produce an additional 6,000 trillion kilocalories per year from 2006 levels to meet the future food needs of a rising population by 2050 (Searchinger et al., 2013). Further, the estimated amount of food wasted by consumers in industrialized countries (222 million tonnes) is almost equal to the total net food production in sub Saharan Africa (230 million tonnes) (Gustavsson et al., 2011).

The UNFAO distinguishes between “food losses” and “food waste” (Gustavsson et al., 2011). Food losses are “the unintended result of an agricultural process or technical limitation in storage, infrastructure, packaging, or marketing” (Lipinski et al., 2013; p1). Food losses are the losses that occur in the production, processing and distribution stages of the food supply chain, for example, through spills, spoilage or abnormal reduction in quality. Food losses are highly

prevalent in developing, low-income regions, such as South East Asia, where around 40 per cent of food loss and waste occurs in the post-harvest and processing stages of the food supply chain (Gustavsson et al., 2011). Food waste, on the other hand, is the wastage that occurs in the retail, food service and human consumption stages of the food supply chain, for example, through throwing away expired food or ordering too much food. Food waste is much more prevalent in industrialised, high-income regions, including China, Korea and Japan, where around 40 per cent of food is lost or wasted in the retail and consumption stages of the food supply chain (Gustavsson et al., 2011).

Figure 1 – Food Supply Chain (adopted from Gustavsson et al., 2011 to include "food service")



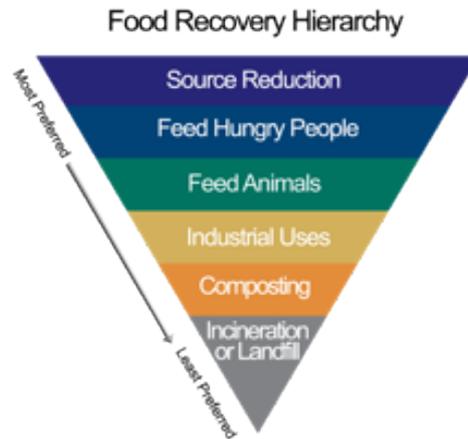
Addressing global food loss and waste along the entire food supply chain is therefore crucial for any strategies to feed a growing population and to sustain our natural resources in the future. It can act as a trigger point for addressing a number of other associated environmental and social issues, such as high and inefficient energy and water use, burning fossil fuels, land use and land degradation, fresh water contamination, poverty and food insecurity. The reality is that if we reduce the amount of food we lose and waste along the entire food supply chain by producing, processing, distributing and consuming food more efficiently, this would also have the flow on effect of a more efficient and equitable use of natural resources generally.

## 1.2 Food waste management to prevention

According to the US Environmental Protection Agency (US EPA) food recovery hierarchy, the most preferred option for addressing food waste along the food supply chain is source reduction – i.e. reducing the amount of food that is actually lost or wasted in the first place. The US EPA food recovery hierarchy also aligns with the EU Waste Framework Directive, which prescribes prevention as being the top priority for waste generally. Prevention is considered a “non-waste” option in the sense that it avoids waste being produced. Preventative options are followed by “waste” options of reuse, recycling, recovery and disposal. As such, waste prevention as a strategy involves a much more thorough understanding of the quantity, source and causes of waste than waste management, which only involves understanding the best way to manage and food waste once it has already been produced (Rodhe & Karlsson, 2002). Understanding the full costs associated with waste, and thus the potential savings for implementing waste prevention

measures, is also central to waste prevention methodologies and strategies (Rodhe & Karlsson, 2002).

Figure 2 – US EPA Food Recovery Hierarchy (source: US EPA website, 2013)



Nonetheless, policy measures and research regarding food waste in industrialised countries have historically targeted food waste management, or so-called “end-of-pipe” measures, as opposed to food waste prevention and source reduction. In 1999, for example, the EU introduced a regional goal to reduce the amount of biodegradable waste going to landfills by 65 per cent by 2016 compared to 1995 levels and set country-specific targets towards meeting this goal (Council Directive 1999/31/EC). In many EU countries, the Directive has resulted in an increase in biodegradable waste sorting at source, incineration, and anaerobic digestion, while biodegradable waste production has remained stable (European Environmental Agency, 2009).

Over the past few years, however, it appears that the EU has begun to move up the food recovery hierarchy and show more of a commitment towards food waste prevention and source reduction. In 2010, the European Commission commissioned a preparatory study on food waste, which found that 90 million tonnes of food is lost or wasted each year in the EU (Monier et al., 2010). As a result, the “Roadmap to Resource Efficient Europe”, which was published by the European Commission in September 2011, identified food as a key sector where resource efficiency should be improved and set targets to halve the disposal of edible food waste by 2020 (European Commission, 2011a). In January 2012, the European Parliament also issued a resolution to halve food waste by 2025 and designate 2014 as the “European Year Against Food Waste” (European Parliament News, 2012). The revised EU Waste Framework Directive also set an obligation for member states to adopt national waste prevention programmes in general by December 2013 (Directive 2008/98/EC), and in 2011 the European Commission published guidelines for member states on preparing food waste prevention programmes (European Commission, 2011b).

In the global community there has also been a clear move towards food waste prevention as opposed to strictly food waste management. The World Resource Institute (WRI) recently released research estimating that halving the current rate of food loss and waste (in kilocalories) by the year 2050 would save enough food to lesson the gap of food required now and food required in 2050 by 22 per cent (Lipinski et al., 2013). The WRI argues that reducing the amount of food that is lost and wasted could be one of the leading global strategies for a sustainable food future. Other organisations, including the UNFAO, have also issued reports highlighting the problems associated with producing food waste and suggesting better food waste prevention measures along the entire food supply chain in both developing and industrialised countries

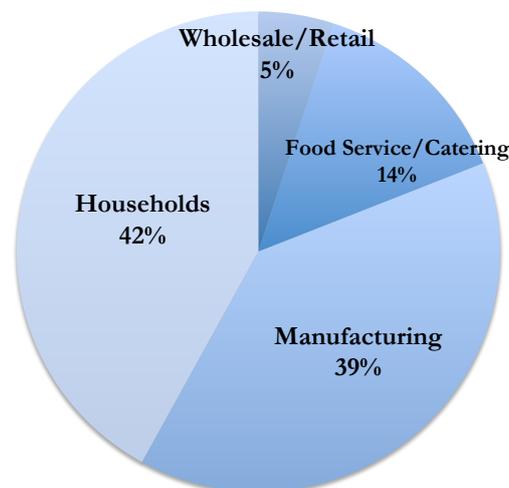
(Gustavsson et al., 2011). The UNFAO recently started “SAVE FOOD: Global Initiative on Food Losses and Waste Reduction”, a campaign targeted at involving all actors along the food supply chain, including policy-makers, to reduce food losses and waste globally (UNFAO website, 2013). There are also a number of other industry- and government-led initiatives emerging to help prevent food waste particularly in industrialised countries, such as China’s “Clean Your Plate” campaign, the Food Waste Reduction Alliance for food manufacturers and retailers in the US, and the Irish Environmental Protection Agency’s “Stop Food Waste” programme.

## 1.3 Problem definition

### 1.3.1 Food waste prevention in restaurants

To effectively prevent food waste, all actors in the food supply chain need to be involved. However, given the high proportion of food that is wasted lower down in the food supply chain in industrialised countries, arguably the greatest potential for food waste prevention in these countries lies with retailers, food service operators and household consumers (Parfitt, Barthel, & Macnaughton, 2010). In the EU, households, wholesale/retail and food service/catering together contribute towards nearly 60 per cent of all food waste produced (excluding agricultural production) (Monier et al., 2010). Further, it is important to tackle food waste that occurs at the later stages of the food supply chain given the potential for life-cycle savings is much higher than food that is lost early on.

Figure 3 – Food waste in the EU27 by source, excluding agricultural production (source: Monier et al., 2010)



So far, most of the literature and initiatives in food waste prevention have focused on households and retail, as opposed to food service and the hospitality sector (Nordic Council of Ministers, 2012). A number of studies and initiatives have already targeted food waste prevention in households, which makes sense given households contribute the most towards food waste in the EU – 42 per cent (Monier et al., 2010). The UK-based Waste Resources Action Plan (WRAP), for example, has done a lot of research on the causes of food waste in households in the UK and how food waste at the household level can be prevented (see Quested & Johnson, 2009 and the Love Food Hate Waste campaign), with a particular focus on increasing consumer awareness about use-by and expiry dates of retail food purchases and the environmental and social implications of food waste.

The UNFAO food waste study did not specifically estimate the amount of food waste produced globally by the food service sector, however, other studies indicate that this source of food waste

is reasonably significant (BCFN, 2012; Gustavsson et al., 2011). The food service and catering sector in the EU, for example, contributes towards 14 per cent of all food waste produced, which adds up to 12.3 million tonnes of food waste each year (Monier et al., 2010). In the UK, restaurants throw out four times the amount of food waste per meal than the average household (SRA, 2010). A Swedish study estimated that restaurants produce 10 per cent of all food waste in the country, equalling 99,000 tonnes of food waste each year (Jensen, et al., 2011). In China alone, it has been estimated that restaurants throw out enough food to feed 200 million people each year, while 128 million people live below the poverty line (China Agricultural University, 2012 – findings translated in Li, 2012).

Governments and organisations have, however, been slow to encourage restaurants to implement food waste prevention strategies, and restaurants have been similarly slow to act. Academic research regarding food waste in restaurants has predominantly focussed on food waste management options, such as the cost benefits of anaerobic digestion or sorting food waste at source as opposed to food waste prevention (see for example Bernstad et al., 2013). Regulations tend to focus on obligations to sort and treat food waste as opposed to prevent food waste, which, while better than landfill disposal, might mean less focus on prevention and make food waste more acceptable to society (Nordic Council of Ministers, 2012). Additionally, reports on the topic of food waste lack actual data and knowledge on avoidable food waste specifically (Nordic Council of Ministers, 2012), even though according to the UNFAO avoidable food waste should be an important focus when it comes to food waste prevention (Gustavsson et al., 2011).

Food waste prevention should be a major concern for individual restaurants as well as society. Food waste is costing restaurants a lot of money. When restaurants waste food, they are also wasting the money spent on purchasing the food; energy, water and labour for processing, preparing and cooking the food; and disposing of the food. In this sense, reducing food waste could be seen as a “trigger point” for reducing energy and water consumption onsite thus making the entire restaurant operations more efficient and therefore more competitive. It has been estimated that restaurants pay around €2 per kg of food waste produced (Environmental Protection Agency Ireland, 2010; WRAP, 2011), and spend around 2-10 per cent of turnover on food that’s wasted (Gunders, 2012; LeanPath, undated; SRA, 2010). In the UK, it is estimated that the hospitality industry could save around £720 million a year by preventing avoidable food waste and diverting unavoidable food waste to anaerobic digestion (WRAP, 2011). Restaurants should also be concerned about food waste as consumers get more and more interested in sustainability generally and making more sustainable choices. Food waste is becoming an important issue in the sustainability debate. Reducing food waste can also reduce restaurants’ GHG emissions and carbon footprint (WRAP, 2011), as well as their entire water and ecological footprint (BCFN, 2012).

Restaurants are gradually moving towards more of a preventative approach to food waste, with organisations and industry publishing guidelines around how restaurants can avoid food being wasted in the first place, and restaurants implementing more efficient, top-down approaches to prevention (see, for example, Nordic Council of Ministers, 2012). Organisations, such as Unilever, are also trying to help restaurants understand the financial benefits involved in reducing food waste and how to save money by reducing food waste, as an incentive for action (Unilever Food Solutions, 2013). However, this movement has been slow and there continues to be a real need for research into food waste prevention and particularly the quantity, source, costs and cause of food waste and setting benchmarks for food waste minimisation. A UK-study identified that two options for reducing food waste in restaurants include spreading best practice and developing campaigns that highlight the extent of waste and the financial benefits of reducing it (Foresight, 2011). Studies that can assist with either of these measures could further encourage

restaurants to implement preventative strategies, and contribute towards overall knowledge on food waste prevention in restaurants.

### **1.3.2 Food waste prevention in quick service restaurants**

While there are minimal academic studies on food waste prevention in restaurants generally, there are even fewer studies with a specific focus on fast food restaurants, also known as quick service restaurants (QSRs). QSRs differ from normal restaurants in the sense that they are fast food restaurants characterised by: (1) fast food cuisine (being, food that can be prepared and served quickly) and (2) minimal table service. To provide fast food services, QSRs are also characterised by a high-degree of off-site food preparation, meaning that the preparation that occurs in the kitchen is generally limited to heating, assembling and serving food. “Fast casual restaurants” are a type of QSRs, whereby the quality of food, service and atmosphere is higher, which results in higher eat-in ratios than traditional QSRs (Tuttle, 2013).

There is a particular need for more studies regarding food waste prevention in QSRs given the sheer size of the industry and its ability to have a global influence on meeting food waste prevention targets and reducing associated energy and water consumption in the process. In 2011, the global QSR industry was valued at \$167,933 million USD, representing 161,488 million transactions, and the market value is expected to increase 30 per cent by 2016 (Marketline, 2012). Further, many QSR restaurant chains are global in nature and have a large number of franchisees. This has the added flow-on effect whereby a “leader” restaurant within a chain can implement food waste prevention strategies and other restaurants within the chain follow suit when they can see the financial and environmental benefits involved. Understanding how targeted food waste prevention strategies can apply to QSRs and how QSRs might be incentivised to reduce food waste should therefore be an important strategy towards meeting food waste prevention targets.

## **1.4 Research objectives and questions**

The purpose of this research is to fill part of the research gap with regards to food waste prevention in restaurants and, in particular, QSRs. Specifically the objective is to use a top-down approach to food waste and understand how waste prevention strategies can apply to addressing food waste in restaurants and QSRs. Waste prevention as a methodology and strategy involves first identifying the quantity, source, cost and cause of waste in a material flow system, before assigning targeted cost-effective measures for its reduction.

The research questions are:

- What is the quantity, source and cause food waste in QSRs?
- How can QSRs benefit financially by preventing and minimizing on-site food waste?

## **1.5 Research Methodologies**

The methodologies used to respond to the research questions involved (1) a literature review of waste prevention methodologies and how they could apply to food waste prevention in restaurants, (2) a case study involving a material flow analysis of food waste in four restaurants within the same QSR chain (to identify the major sources and causes of food waste) and cost calculations, (3) a comparative analysis between the case studies, and between the literature and the case studies, to identify the different factors contributing to food waste in the case study QSRs and possible targeted food waste prevention measures.

### **1.5.1 Literature review**

The literature review was undertaken to (1) explore how waste prevention methodologies could be applied to food waste prevention in restaurants and QSRs, (2) explore the quantity, source and cause of food waste in restaurants and identify benchmarks for food waste best practice, and (3) develop a methodology for quantifying and comparing food waste in the QSR case studies.

Previous studies and “grey” literature was identified using Internet search engines, University Library search engines and databases. The majority of literature identified related to food waste prevention in restaurants generally. The literature was sorted into the following groups:

- (1) Waste prevention methodologies: Literature regarding waste prevention methodologies generally and how the methodologies work and could be applied to food waste prevention in restaurants.
- (2) Quantifying food waste: Literature that identified the quantity and source of food waste in restaurants and QSRs, including methodologies and benchmarks or indicators used to quantify and compare food waste and food waste best practice in restaurants and QSRs (i.e. how much food waste the average restaurant produces).
- (3) Food waste causes and prevention strategies: Literature that identified the causes of food waste in restaurants and QSRs and prevention strategies and initiatives and, if possible, any outcomes of these strategies and initiatives.
- (4) Financial incentives: Literature that calculated the costs of food waste in restaurants and provided methodological insights on how the costs of food waste to restaurants could or should be calculated.

The literature was analysed for applicability to QSRs in particular. Identified strengths and weaknesses of methodologies were highlighted, as well as ideas for how these weaknesses or strengths could be addressed in the QSR case study.

### **1.5.2 Case study**

#### **Overview**

The purpose of the case study was to explore the reasons and conditions why some restaurants produce a lot of food waste while other restaurants only produce a little, in order to identify the main source and causes of food waste in QSRs. The case study involved selecting two “higher performing” restaurants (Europe A and Europe B) and two “lower performing” restaurants (China A and China B) within the same QSR chain when it comes to the amount of food waste the restaurants produce. The restaurants selected were then analysed and compared (using a triangulation of methodologies) to identify factors that increase or reduce the amount of food waste each restaurant produces.

#### **Restaurant selection**

The QSR chain selected for this study is a large, global restaurant chain. As such, it has the ability to implement global change when it comes to food waste reduction. Four restaurants were chosen to be analysed – two in Europe (“higher performing”) and two in Shanghai, China (“lower performing”). The four restaurants analysed were chosen based on two factors: (1) the substantial difference in the amount of waste produced by the restaurants, and (2) the importance of these specific restaurants to the QSR chain currently and in the future. Europe A is the “concept store” for the restaurant chain so should provide a good benchmark for all other

restaurants within the chain. Europe B is extremely similar to Europe A, is located in a similar European country and also produces a low amount of food waste. According to representatives, China is considered a major growth area for the restaurant chain over the next ten years, so focus by the restaurant chain on China and sustainability in these stores will increase substantially during this time. China A is located in an urban area whereas China B is located in a slightly rural developing area.

### **Primary data collection**

The data collection was made during site visits to the four restaurants in June and July 2013.<sup>2</sup> Site visits involved collecting primary data on food waste, interviewing staff members (restaurant staff, the food and beverage manager, the kitchen manager, the sustainability specialist and the food and beverage specialist), reviewing internal company documents and statistics (including Daily Sales Reports, yearly Item Contribution Reports, waste figures, energy and water consumption figures, communication documents, and food waste prevention guidelines), making primary observations and taking photos for validation. In China, staff members who had sufficient English skills translated interviews and documents were loosely translated during site visits as required.

### **Methodology**

The methodology for the case study involved comparing three different focus points: (1) the quantity and source of food waste in each restaurant system, (2) the internal and external factors contributing towards food waste production in each restaurant system (i.e. the causes), including current waste prevention measures, and (3) the estimated costs of food waste.

(1) **Quantity and source** – First, based on observations and the literature review, a process and material flow diagram (MFA) was constructed. The MFA identified the different food waste source points in the restaurant system.

- In Europe, onsite waste audits were subsequently undertaken in each site over one full day of operations to calculate the quantity and source of avoidable food waste produced by the restaurant. Food waste was collected, separated into main food waste sources (as identified through the MFA) and weighed, and visual estimations were made as to the weight proportion of food waste avoidability (as defined by the UNFAO in Gustavsson et al., 2011). Photos were also taken of all food waste collected for validation.
- In China, actual waste data could not be collected due to logistical and language constraints. Instead, estimations were made on the quantity and source of food waste based on observations and interviews with staff members. The weight proportion of avoidable food waste was estimated based on a 2-hour snapshot survey of customer plate waste at one of the venues and assumed to be the same across both venues.<sup>3</sup> It was also based on information obtained through interviews and further observations. Photos were also taken of plate waste for validation.

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<sup>2</sup> The methodology for data collection used in this thesis was developed by the author. However, the site visits were conducted with another Master's student also involved in a thesis on a similar topic with the same company. Europe B was visited twice, and the second time it was only visited by the other student and not the author. The other student collected primary data on behalf of the author.

<sup>3</sup> The 2-hour snap shot survey involved randomly selecting used plates and bowls from the customer plate trolley in the kitchen (including empty plates and bowls), weighing and recorded the amount of food waste on each plate, noting the type of food waste (and whether it is avoidable or unavoidable) and taking photos.

- In all restaurants, the quantity of food waste was also calculated per employee and per customer ticket in order to compare the results (based on internal company statistics provided by each case study restaurant).
  - Estimations were made about the weight proportion of prepared/cooked food consumed against food wasted in each restaurant studied to fully understand how much food is wasted in each restaurant and to develop Sankey diagrams. The estimations were based on estimations as to the average weight of solid food per customer ticket in each restaurant (based on the average number of items per customer ticket and the average weight of meals), the total number of customer tickets per day, and the total amount of pre- and post-consumption waste produced per day. The assumptions and calculations for each restaurant are further explained in the Appendix.
- (2) **Factors contributing to food waste production** – In each restaurant system a number of factors were identified that contributed towards food waste production. These factors were identified through onsite observations, the results of the MFA, semi-structured interviews with staff members and general assumptions based on knowledge gained through site visits.
- (3) **Estimated costs of food waste** – The costs of food waste produced in the restaurants over one day of operations were then calculated based on methodologies identified in the literature analysis. Unfortunately, Europe B had to be excluded from the cost calculations because the restaurant could not provide the information within the required timeframe. In China, the costs were obtained in Chinese Yuan (RMB), but have been translated to Euro for comparability.<sup>4</sup> The costs were based on a combination of:
- **The estimated costs of food purchased and wasted** – For Europe A, these costs were calculated based on the costs of kitchen food waste recorded by the restaurant for the month of May as a proportion of turnover, as identified by the case study restaurant. For China, costs were based on yearly turnover and yearly kitchen food waste recorded (as a proportion of turnover) – adjusted to average daily turnover and costs.
  - **The costs of food waste disposal** – For Europe A, these costs were based on the average cost per kg of food waste collection over Jan-May 2013 and the average daily operating costs of the food waste dewaterer (as provided by the QSR restaurant). The total amount of waste produced daily was adjusted 30 per cent to account for the fact that the dewaterer reduces the weight of waste by an estimated 30 per cent. For China, the daily costs were based on the actual yearly costs paid by the restaurants for waste disposal adjusted to average daily costs.
  - **The cost of processing, preparing and cooking wasted food** – For both Europe and China, this cost was based on an estimate of the proportion of food eaten versus food wasted (in weight). These estimates were based on estimates on the total weight of the average meal sold to customers multiplied by the total number of daily customer tickets sold (the basis for the estimations is further explained in the Appendix). The proportion of food wasted was then applied to total estimated costs for energy and water (as provided by the restaurant case studies), and total estimated costs of staff.

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<sup>4</sup> Chinese Yuan were exchanged to Euro based on an international exchange rate of 1RMB = €0.12 as at 27 August 2013 (www.xe.com)

- **Avoidability** – The total cost of food waste in all cases was then adjusted to account for avoidability so that essentially two estimations on the costs for each restaurant were made: the costs for all food waste and the costs for only avoidable food waste. The avoidable food waste costs were based on the estimated weight proportion of avoidable to unavoidable food waste identified in the MFA. For comparability, the total cost of avoidable food waste was also calculated as a proportion of daily turnover in each restaurant (daily turnover was provided by each case study restaurant either in the form of actual daily turnover for Europe A or yearly turnover averaged to daily turnover for China A and B).

### 1.5.3 Comparative analysis

The comparative analysis involved both comparing the findings of the four case studies, and comparing the findings of the case studies with the literature. The case studies and the literature were compared on the following parameters (1) the quantity and source of food waste (through MFA-identified source points) using total weight, total weight per customer ticket, and total weight per employee as benchmarks; (2) the internal and external factors contributing to food waste production – grouped in to pre- and post- consumption food waste, and (3) the costs of food waste converted to Euros, using both total costs and costs as a proportion of daily turnover.

## 1.6 Study scope and limitations

### 1.6.1 Definition of “food waste”

This study follows the UNFAO and WRI definitions of “food waste” (Gustavsson et al., 2011; Lipinski et al., 2013), adjusted to account for the WRAP definition of “avoidable food waste” (Quested & Johnson, 2009). Food loss and waste in this study refers to “...the decrease in edible food mass throughout the part of the supply chain that specifically leads to edible food for human consumption.” (Gustavsson et al., 2011 p2). This study distinguishes between “avoidable” and “unavoidable” food waste. In this study, “avoidable” food waste includes (Gustavsson et al., 2011; WRAP, 2012; Lipinski et al., 2013): all food that was produced and intended for human consumption but is not ultimately consumed by humans – i.e. all food that was originally intended for human consumption but leaves the food supply chain for non-human consumption (including for the production of biogas, compost or energy through incineration). “Unavoidable” food waste is (Gustavsson et al., 2011; WRAP, 2012; Lipinski et al., 2013): inedible by-products that were never intended for human consumption, such as bones, vegetable peelings and egg shells.

Primarily for logistical reasons, the following types of food waste were not within scope of this study:

- Food and drink waste that leaves the restaurant system through the waste water system (it was not possible to quantify this food waste because it was not separated at source).
- Coffee grounds (these were excluded by default given liquid waste from drinks were also excluded).
- Waste oil (this was excluded because it was in a different waste stream in the restaurant system than ordinary food waste and it was never intended for human consumption meaning it would, in any event, be classified as unavoidable food waste).

Further, this study is limited only to food that is wasted at the food service stage of the food supply chain. It does not include food that was wasted at any other stages in the food supply chain, including production, post-harvest handling and storage, processing, distribution and retail or at home consumption (for food that was taken off-premise by customers). As such, only food

waste that occurs within the boundary of the QSR case studies is included within the scope of the case study. This means that the study specifically does not include food that was turned down by the restaurant on receipt (for example due to quality reasons) – this food generally is sent back up the chain to the supplier for disposal, meaning the wastage does not actually occur at the restaurant stage (Company Hygiene Plan, 2010).

### **1.6.2 Limitations**

The first limitation of this study is that the case study only relates to restaurants within one restaurant chain. However, this approach was chosen because it made the restaurants much easier to compare given they all operate in essentially the same manner. Also the specific type of restaurant has been explained and defined as a fast casual restaurant, meaning the findings would also apply to other similar restaurants. Additionally, the methodology applied in the case study could easily be applied in any other type of restaurant.

Secondly, there are some limitations in the data obtained. In Europe, the findings of the case study only relate to one day of data collection. The semi-structured interviews, however, identified that the source proportions identified in the data collection were standard for a typical day of restaurant service, so while the total amounts of waste may vary seasonally, it is highly likely that the source proportions will be typical throughout the year. In China, no primary data for waste statistics could be collected so waste statistics are based entirely on estimations made by company staff and observations. Furthermore, the Sankey diagrams and cost estimations for the costs of processing, preparing and cooking food that is wasted are based on rough estimations about the proportion of the weight of food consumed. This is because actual data on the weight of food consumed was not available. While care has been taken in developing these estimations, it is unlikely that they are 100 per cent accurate. This limitation has been further explained and justified in the case study chapter and the Appendix.

Third, there are limitations in the methodology used to estimate the costs of processing, preparing and cooking food that is wasted. This methodology is based on the same methodology used for the Sankey diagrams and thus may not provide 100 per cent accuracy for these costs. As such, the costs should only be viewed as estimations.

Fourth, (as previously explained) this study only relates to food waste that occurs on-site in the case study QSRs. As such, food waste that occurs off-site – either further up the food supply chain or through customers taking food home and later disposing of the food – is not included in this study. Certain types of food waste are also excluded for the study, namely liquids, coffee grounds and waste oil. However, the exclusion of these foods has been explained and justified in chapter 1.6.1 of this report. Further, coffee grounds and waste oil would not be considered “avoidable” food waste under the UNFAO definition, and previous studies identified (including WRAP, 2013 and SRA, 2012) did not include liquid food waste.

### **1.7 Audience**

This research will be of particular interest to the case study restaurant analysed in its development of a global food waste prevention strategy (including the estimated financial benefits) and in helping the restaurant identify ways in which to reduce energy and water consumption through implementing food waste prevention measures. The findings will provide a helpful insight into the source and causes of food waste in different QSRs within the same chain and how the sources and causes can vary depending on a range of factors.

This research will also be of interest to actors in the food supply industries, but particularly in the food service industries and QSR industry. The methodology developed in this research will

provide a helpful starting point for other restaurants to apply waste prevention strategies to reduce avoidable food waste at source and hopefully contribute towards meeting the EU 2020 targets and global food waste reduction targets. The findings, particularly with regards to costing, will also help provide restaurants and QSRs specifically with financial incentives to reduce their own food waste. The study will also be interesting in that it highlights the difficulties involved in implementing global food waste prevention strategies within the same restaurant chain given the difference in food waste quantity, cause and source in restaurants within the same QSR chain, as well as the difficulties involved in setting benchmarks and measuring and monitoring food waste.

Finally, this research could be of interest to policy-makers and NGOs in the development of food waste prevention policies by helping them better understand how QSRs operate and the importance of forecasting, food health and safety regulations, and consumer behaviour towards food waste production and prevention. Policy-makers and NGOs could also use the findings to help industry develop food waste prevention tools to assist restaurants to reduce food waste at source and potentially make financial savings.

## 1.8 Report structure

**Chapter 1 – Introduction** – This chapter presents the nature of the food waste problem and, in particular, the movement towards food waste prevention. It also describes the research gap and problem definition for food waste prevention in restaurants and, in particular, QSRs, and the role of this research towards helping to fill this knowledge gap. It presents the objectives and research questions, the research methodologies, research scope and limitations, and thesis outline, and describes the audience for which this research may be useful.

**Chapter 2 – Literature Analysis** – This chapter presents the literature analysis of food waste prevention in restaurants. It also discusses how findings of previous studies might apply to this study with regards to quantity, source, cost and cause of food waste, as well as some best practice strategies and initiatives for food waste prevention. It also provides methodological insights for the case study.

**Chapter 3 – Case Study** – This chapter presents the main findings of the QSR case study, being (1) the MFA for four restaurant systems, (2) the factors contributing towards food waste in each restaurant; and (3) calculations for the estimated total costs of food waste in each restaurant system.

**Chapter 4 – Comparative Analysis** – In this chapter, the findings of the case studies are compared and analysed against each other and against the findings of the literature.

**Chapter 4 – Discussion** – This chapter discusses the significance of the findings of the study generally, the general applicability of findings and the appropriateness of research methodologies. It also provides some suggestions for restaurants and QSRs as a result of the findings of the research, and suggestions for further research or improvements to the applied methodologies.

**Chapter 5 – Conclusions** – This chapter summarises the main findings and lessons learned in the course of this research, highlights main research contributions and summarises suggestions for further research.

## 2 Literature analysis

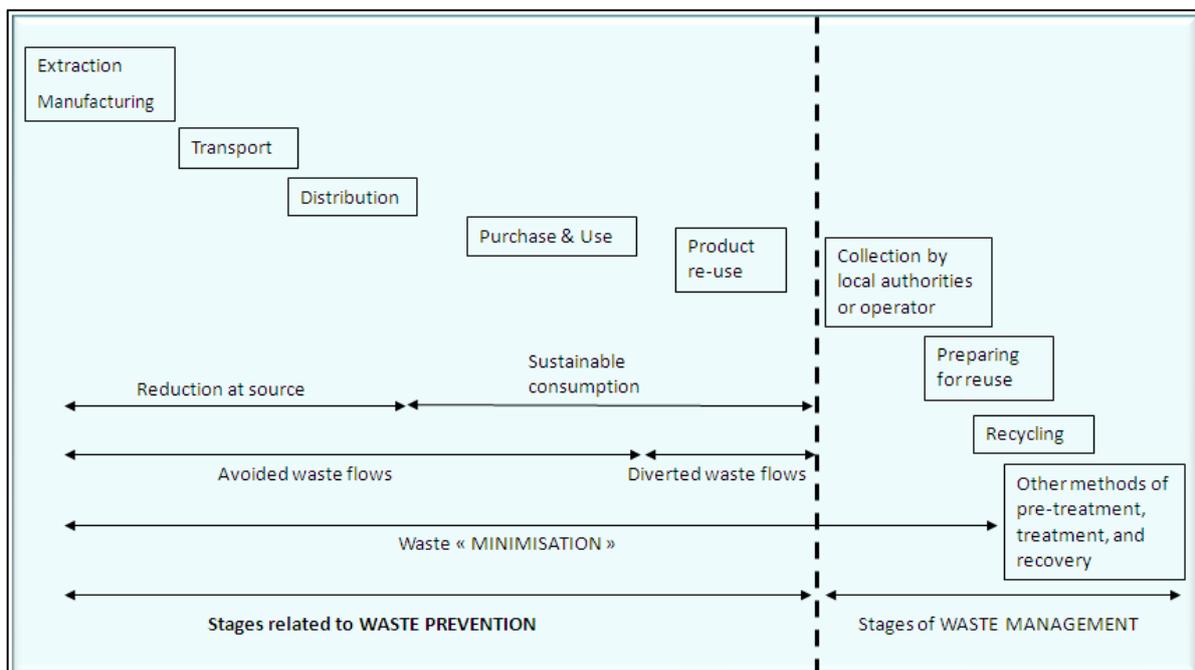
### 2.1 Waste prevention strategies

#### 2.1.1 What are waste prevention strategies?

Waste prevention strategies are central to the resource efficiency and cleaner production (RECP) concept. The United Nations Environment Programme (UNEP) defines cleaner production as “the continuous application of an integrated preventive environmental strategy applied to processes, products and services to increase eco-efficiency and reduce the risks to humans and the environment” (UNEP, 1989). More recently, the definition of cleaner production has evolved to include resource efficiency by addressing three sustainability dimensions: production efficiency, environmental management and human development (UNIDO website, accessed 2013). RECP involves a holistic understanding of processes and material flows within a system, including the source and cause of energy and water consumption, and waste production, to identify where energy and water use, and waste production, can be minimized, and to find ways to reduce the impact of processes, products and services on the environment and human development.

As discussed in the Introduction, the revised EU Waste Framework Directive sets an obligation for member states to adopt national waste prevention programmes by December 2013 (Directive 2008/98/EC). In line with RECP, the EU Waste Framework Directive defines waste prevention as being the measures taken before a substance, material or product becomes waste that reduce the quantity of waste, the adverse effects of waste on the environment or human health and the content of harmful substances (Directive 2008/98/EC, article 3(12)). The EU guidelines on waste prevention programmes say waste prevention can be achieved through reducing the quantity of material used in the creation of products and increasing the efficiency with which products are used (European Commission, 2012). The guidelines also say that prevention can either be “strict avoidance” of waste or “diversion of waste flows” through extending a product’s life time or reusing a waste product.

Figure 4 – Illustration of the definition of “waste prevention” (source: European Commission, 2012)



In this sense, waste prevention strategies involve identifying the source and cause of waste within a system – the waste “hot spots” – in order to assign targeted measures to minimize its production. Prevention strategies also involve identifying ways in which the life time of products can be expanded, or ways that products can be reused. Waste management (or end-of-pipe measures), on the other hand, involves looking specifically at how to manage and deal with waste once it has already been produced through, for example, waste treatment and waste recovery.

Waste prevention in general is beneficial for a number of reasons. It can contribute to a reduction in environmental impacts associated with waste management (including reductions in methane emissions from landfills and carbon dioxide from incineration), improved resource efficiency through energy savings and reduced material use (as well as “hidden” environmental impacts of resource use), and reductions in the production of hazardous waste (European Commission, 2012). The major benefit of implementing waste prevention strategies for firms is that they can save money through a more efficient use of natural resources, while reducing the adverse impacts of their activities on the environment. Many waste prevention strategies, particularly the “low-hanging fruit” such as improved housekeeping or process improvements, can be implemented at low-cost and have immediate waste prevention benefits. RECP encourages firms to reduce waste at the source rather than end-of-pipe, which also reduces costs by making processes in general much more efficient, rather than managing waste and the environmental affects of waste after it has been produced. RECP in general also helps firms comply with legal requirements regarding waste, discharges and emissions.

Waste prevention also essentially lies within the realm of life-cycle thinking as well as RECP (European Commission, 2012). Life-cycle thinking (LCT) seeks to identify possible improvements to goods and services to lower environment impacts and resource use across all life cycle stages, from extraction to disposal (Joint Research Centre on Life Cycle Thinking and Assessment website, 2013). LCT is the idea that RECP measures should also take into account the life-cycle environmental impacts of goods and services to best identify where the environmental impacts can be reduced and target the environmental impact “hot spots” along the life cycle of a good or service.

### **2.1.2 Material Flow Analysis (MFA)**

The EU waste prevention guidelines and the UNIDO Cleaner Production Toolkit both suggest using Material Flow Analysis (MFA) as an analytical framework for measuring energy and resource use within a system (European Commission, 2012; UNIDO, undated). From the perspective of waste, MFA is a systematic approach aimed at presenting an overview of materials used in a company; identifying the point of origin, the volumes and the causes of waste; creating a basis for an evaluation and forecast of future developments; and defining strategies to reduce waste (UNIDO, undated). Central to MFA is understanding how a system works and how material – including energy, water and waste – flows through a system, to identify and target consumption and waste “hot spots”. MFA involves analysing the energy, water and material inputs and outputs within a system. As such, one of the major focus points for MFA within a system regarding waste is understanding where in the system waste is produced and why. This involves analysing process steps, preparing material flow charts, measuring the quantity of waste produced, and where in the process system it is produced (i.e. the source).

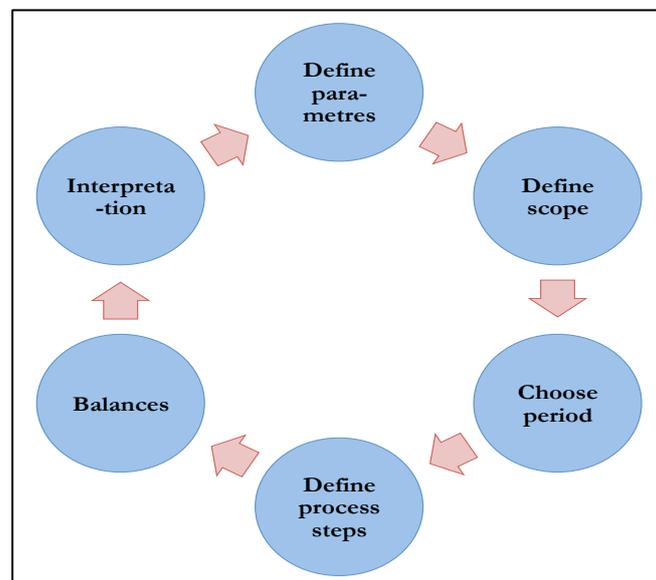
MFA tools are also helpful for setting indicators and baselines for monitoring and evaluation. Article 29 of the amended EU Waste Framework Directive says that, along with developing waste prevention strategies, member states must also adopt targets to monitor and evaluate the success of waste prevention measures and progress towards objectives (Directive 2008/98/EC). MFA tools are helpful to identify baselines and indicators for setting targets for reducing resource

use. Waste prevention strategies can only be accurately evaluated for effectiveness and efficiency if there are baselines and indicators for such evaluations to be made.

The UNIDO guidelines suggest taking the following six essential steps when conducting an MFA (UNIDO, undated):

1. Define the parameters – Which materials within a system will be traced?
2. Define the balance scope – Will the MFA involve looking at a company as a whole or just specific processes?
3. Choose the balance period – What period of time will the MFA apply to?
4. Identify and define production steps – What are the steps within a system and how can these be presented in a flow chart (flow charts illustrate the product processes)?
5. Balances – What are the inputs and outputs and where do they occur in the flow chart?
6. Interpret flow charts and balances – Retrace material charts and key figures to identify the “hot spots”, compare to reference points, and rank measures in order of importance.

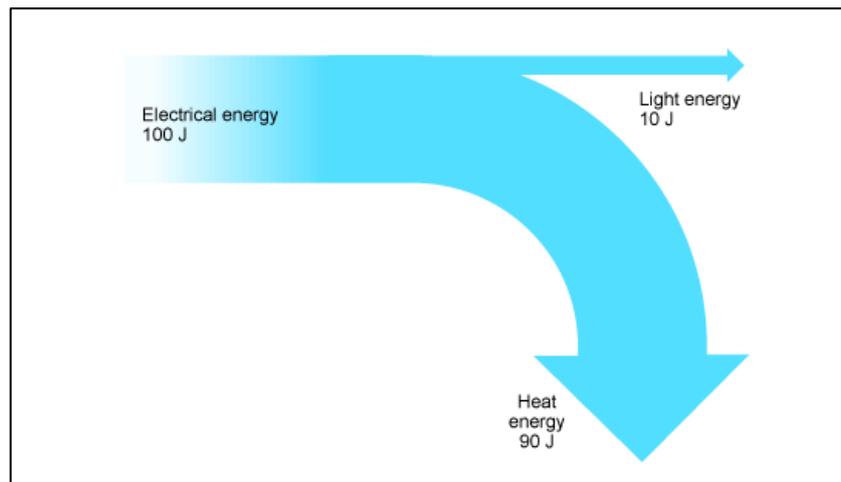
Figure 5 – Essential steps for conducting MFA (source: UNIDO, 2013)



### 2.1.3 Other methodologies for quantifying material flows

MFA is not the only methodology for understanding material flows and resource use “hot spots” when it comes to waste minimization and RECP. MFA’s should be used alongside other methodologies and cleaner production tools, such as Sankey diagrams, root cause analysis and qualitative data collection, to fully understand how a system works and how waste prevention measures could be applied. Sankey diagrams are helpful tools for understanding material flows because they are effective for in illustrating and communicating the relative sizes of flows in a system, which supports the process of focusing intervention measures on consumption (Rodhe & Karlsson, 2002). Root-cause analysis is another helpful tool for identifying the causes of waste in a system. Root-cause analysis is an illustrative technique to identify and structure the causes of a problem. Root-cause analysis is structured by focusing on four or five root causes of an effect: methods, machines, people, materials and measurements. The technique is useful to illustrate causes are not only technical, but also induced by employees, production methods and so on (Rodhe & Karlsson, 2002).

Figure 6 - Example Sankey diagram for a light bulb (source: BBC, 2013)



To understand system processes and identify the root source and cause of problems within a system, all of the above tools can be further supported by qualitative data collection. Qualitative data can be obtained through, for example, interviews with people involved in a system, interviews with specialists, primary observations of processes and procedures, and reading through company documentation (UNIDO, undated; Rodhe & Karlsson, 2002).

#### 2.1.4 Full-costing waste

Understanding the full costs involved in producing waste is another major component of cleaner production and waste prevention strategies. Understanding and calculating the full costs of waste to a firm provides further financial incentives for implementing waste prevention strategies. Some times on the face of it, waste measurement strategies look more financial beneficial for firms, particularly in the short-term. However, waste prevention strategies may require high investment upfront but have much more beneficial long-term outcomes financially and environmentally. Full-costing involves looking at not only the direct costs associated with waste, such as the costs of waste disposal, but also the indirect less obvious costs, including the costs of purchasing items that are ultimately wasted, and the money spent on electricity, water and labour required to process material that is eventually wasted (Rodhe & Karlsson, 2002). In this regard, understanding the full costs, including “hidden” costs, enables firms to understand the full savings of investing in waste prevention measures and conduct more accurate cost-benefit analyses.

## 2.2 Food waste prevention in restaurants

While waste prevention strategies and the MFA framework relate to RECP generally, they can also be applied to preventing food waste, and specifically, food waste in restaurants. Food waste prevention in restaurants would require a focus on minimizing the production of food waste at source (through, for example, better processes and procedures, reuse or redistribution) as opposed to food waste management measures. Under the EU Waste Framework Directive definition of “prevention”, food waste prevention would not include, for example, composting organic waste, as this would be considered a food waste management measure (European Commission, 2011b). Preventative approaches to food waste in restaurants involves a much more thorough understanding of the source and cause of food waste within a restaurant system than food waste management – i.e. a top-down approach. This would enable food waste reduction measures to be targeted towards eliminating the cause of food waste as opposed to just treating the symptoms, which so-called end-of-pipe measures do.

## **2.3 Material Flow Analysis for food waste in restaurants**

### **2.3.1 Overview**

To apply the UNIDO MFA framework to mapping food waste in restaurants, the first two steps are somewhat straightforward. The specific focus parameter in this case would be mapping food waste material flows, and the scope would be material flows specifically within the confines of a restaurant system (i.e. the food waste that occurs on-site, and not further up or down the food supply chain). There is, however, a need for a clear and consistent definition of “food waste” (European Commission, 2011b). As for the following steps in the MFA methodology, we would need to understand the food material flows within a restaurant system and how to quantify food waste in restaurants in order to develop indicators and benchmarks. The following chapter explores definitions of “food waste”, and tools and indicators used in previous studies for quantifying and mapping the source of food waste within restaurant systems.

### **2.3.2 Defining food waste**

A number of studies have sought to define “food waste”. The most commonly followed definitions, however, appear to be those used by the UNFAO and the UK-based Waste Resources Action Plan (WRAP). The UNFAO defines food loss and waste to mean a decrease in the edible food mass that was originally intended for human consumption (Gustavsson et al., 2011). As such, food loss and waste does not include inedible food (such as bones and vegetable peelings) or food that was not produced for human consumption (such as energy crops or animal feed). It does, however, include food that was intended for human consumption but leaves the food supply chain for non-human consumptive purposes (such as food waste used to produce biogas or compost). Similarly, WRAP distinguishes between “avoidable” and “unavoidable” food waste (Quested & Johnson, 2009). Avoidable food waste includes food that was at some stage intended for human consumption, and unavoidable food waste is food that is not considered edible, such as vegetable peelings, eggshells and bones, and was never intended for human consumption. WRAP also defines a third category as “partially avoidable” food waste, being food waste that is considered unavoidable by some but not by others, such as bread crusts.

These two definitions of food waste align in that UNFAO’s definition of food waste is similar to WRAP’s definition of “avoidable” food waste, and food waste specifically excluded from the UNFAO definition aligns with WRAP’s definition for “unavoidable” food waste. However, for clarity, the WRAP definition of avoidable and unavoidable food waste is used in this study to easily distinguish between the two types of food waste.

### **2.3.3 Quantity and avoidability**

The measuring and monitoring of food waste, and specifically food waste in restaurants, should be consistent to enable restaurants and other actors involved in food waste (such as policy makers) to track progress and benchmark. Comparability and consistency is important to be able to set benchmarks and compare the performance of one restaurant against another, or of one restaurant throughout a period of time. Accurately measuring food waste also allows stakeholders to adapt their strategies when measures are not demonstrating expected results (European Commission, 2011b).

Many studies have sought to measure food waste in restaurants generally from a macro level to identify the amount of food waste produced by national restaurant sectors. However, these studies used different indicators when measuring food waste in restaurants, and also defined “food waste” to include and exclude different things. As such, they are extremely hard to compare against one another (see European Commission, 2010; Nordic Council of Ministers, 2012; SMED, 2011, WRAP, 2013). Further, only two studies identified (WRAP; 2013 and Nordic

Council of Ministers, 2012) sought to specifically measure “avoidable” food waste in restaurants, with the other studies looking at all food waste produced.

The European Commission study sought to estimate the total amount of food waste produced by the food service industry in the EU (including restaurants, bars, QSRs, catering venues and so on) (Monier et al., 2010). The study estimated that each year in the food service/catering industry, each person in the EU12 produces 12 kg of food waste, and each person in the EU15 produces 27 kg of food waste, and that the difference likely reflects differences in disposable income or consumption behaviour. Similarly, the Norden study sought to estimate the total amount of food waste produced by the hospitality sector in the Nordic countries (Nordic Council of Ministers, 2012). The study reviewed national studies and found that the sector produces a total of 680,000 tonnes of food waste per year, 456,000 tonnes (or 67 per cent) of which is “avoidable” food waste. This was based on estimations that, in the hospitality sector, each inhabitant produces 27 kg of food waste each year, 18 kg of which is “avoidable”. While the Norden study is helpful for the measure of avoidability, both studies are limited in that they only look at all waste produced by the sector as opposed to individual restaurants. This means they are not helpful for setting benchmarks for comparability with individual restaurants on a micro scale.

The Norden study highlighted a need for better statistics on the amount of avoidable food waste produced by restaurants and better reporting systems – specifically for comparability. Norden suggested that food waste indicators should involve comparing food waste to the number of servings or turnover:

“Operators within the hospitality sector should...measure their avoidable food waste and develop appropriate key figures for internal reporting. In addition to assess both total food waste and avoidable food waste, these amounts should be compared *by number of servings and/or food turnover*. Such key figures should be developed as an efficient tool for each operator and also for society in order to follow up national avoidable food waste ambitions and targets.” (Nordic Council of Ministers, 2012; p77)

Along these lines, the WRAP study provides a more helpful starting point for estimating best practice baselines and targets (WRAP, 2011). The WRAP study sought to calculate the total quantity and composition of all waste produced by the hospitality sector in the UK, broken down by venue type. The WRAP study calculated the amount of food waste produced through a compositional analysis of a day’s worth of waste produced by 138 different venues. The compositional analysis was then read alongside national waste data statistics to ensure the data on the amount of waste produced was accurate. In the compositional analysis, food waste was sorted into “avoidable” and “unavoidable” waste categories. Following this methodology, the WRAP study found that across all hospitality establishments, around 67 per cent of food waste was classified as “avoidable” (which is the same as Nordic Council of Ministers, 2011). In QSRs and restaurants, however, 70 per cent of food waste was classified as “avoidable”. For indicators, WRAP based its calculations on the total amount of food waste produced each year per venue and per employee. In this way, the calculations can be comparable to other restaurants of similar size when comparing the total amount of food waste they produce to the number of employees they have.

Table 1 – The average amount of food waste produced by restaurants and QSRs in the UK each day (in kg) per company and per employee, broken down by size (number of employees)

Restaurants						
Average food waste disposed of per day (kg)	No. Employees					
	1-9	10-19	20-49	50-99	100-149	250+
Per employee	2.1	3.1	3.4	0.4	0.5	1.2
Per company	10.8	45.8	117	21.7	83.2	302.6
Quick Service Restaurants (QSRs)						
Average waste disposed of per day (kg)	No. Employees					
	1-9	10-19	20-49	50-99	100-149	250+
Per employee	1.7	1.7	2.1	2.1	2.1	2.1
Per company	8.4	25.2	75.5	167.7	366.1	524.0

**Notes:**

70 per cent classified as “avoidable”

“Food waste” only included waste in the municipal waste stream (i.e. didn’t include food waste that had been specifically separated), and excluded liquid wastes that had entered the wastewater system.

Source: Author’s own calculations based on data obtained from WRAP, 2011.<sup>5</sup>

There are a number of limitations with the WRAP study. The compositional analysis involved a sample size of only 138 venues in total, and even fewer restaurants and QSRs, meaning outlier survey participants could potentially skew the results. This could particularly be the case with regards to restaurants with more than 50 employees. Further, it also does not provide many different bases for comparison, as suggested by Norden, including the amount of waste per customer or item, or food waste as a cost proportion of turnover. The WRAP study did mention establishing benchmarks related to the number of customers served, however, any findings were not published. WRAP also noted that during the literature review, no previous studies were identified that had looked at the relationship between waste and meals served (WRAP, 2011). The amount of waste produced per customer or item is important, and perhaps even more so than per employee, because it provides an indication of the volume of customers and the amount of food that actually goes through a restaurant system. However, the WRAP study still provides a good basis for comparison with QSRs in industrialised countries. It provides some clear baselines for how much food waste the average restaurant and QSR in the UK produces based on size.

The WRAP study also provides some insights to the differences in the quantity and avoidability of food waste produced by restaurants and QSRs. Smaller restaurants produce more waste than smaller QSRs, but the results are vice versa as restaurants and QSRs get bigger. This could be due to the specific nature of establishments – small QSRs would likely consist of “hole in the wall” type establishments that probably have a high proportion of take-out customers, reducing the amount of food waste produced by customers’ onsite substantially. Also, small restaurants would

<sup>5</sup> Calculations are based on the average amount of residual mixed waste disposed of by QSRs and Restaurants per company and employee broken down by company size (WRAP, 2012; p37). These averages are then adjusted to account for 51 per cent of total residual waste from QSRs and 44 per cent of total residual waste from Restaurants being food waste (WRAP, 2012; p46-7). They have been further averaged to daily kg amounts from yearly tonnage.

have a much higher degree of onsite preparation than small QSRs due to the general nature of QSRs, which inevitably results in more waste. As QSRs get larger, they probably have higher eat-in ratios, where people visit for the restaurant experience rather than a quick meal, and are more likely to leave food waste on-site (as identified in WRAP, 2013 and further discussed in Chapter 2.4 of this report).

The WRAP study is not the only study to estimate the amount of food waste produced by restaurants through a “per employee” approach. A Swedish study also used this approach to estimate the total amount of food waste produced by restaurants in Sweden (Jensen et al, 2011). The study looked at annual food waste statistics compiled by Waste Sweden and compared this to national employee data. The study found that each restaurant produces on average 1,059 kg of food waste per employee per year, which is an average of 2.9 kg per employee each day. Using this approach, the study found that all restaurants in Sweden produce 99,000 tonnes of food waste per year (or 10 per cent of all food waste produced). Both WRAP and the Swedish study excluded liquid food waste. They also have slightly different scopes when it comes to food waste due to the methodologies used and the current waste disposal situation in each country. Jensen et al (2011) focussed primarily on sorted food waste, while WRAP focused on food waste in the municipal waste stream.

#### **2.3.4 Process mapping and food waste source-points**

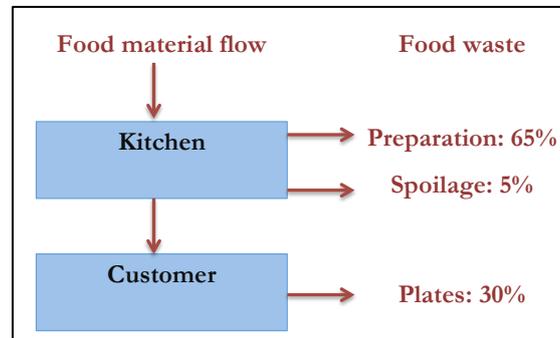
The above studies did not analyse material flows within a restaurant system to identify food waste source-points. When it comes to conducting an MFA, identifying the food material flows within a restaurant system and the food waste source-points (and not just the amount of food waste produced overall) is extremely important. Waste prevention, by its very nature, means identifying the source and cause of food waste to prevent it from being produced.

Food within a restaurant system follows a number of steps that can be divided into two main stages: pre-consumption and post-consumption. Pre-consumption is essentially all the steps the food goes through before it reaches the consumer (i.e. in the kitchen), including food storage; preparation, processing and cooking; and serving the food. Post-consumption is everything that happens once the food arrives with the consumer, which naturally includes consumption. Food waste sources in restaurants can therefore be separated into pre-consumption and post-consumption food waste (LeanPath, undated). Pre-consumption food waste is all food waste that occurs in the hands of the employees and before the food arrives with the consumer. Pre-consumption food waste includes, for example, preparation waste, food spoiled in storage, spillages, and overcooked food. Post-consumption food waste, on the other hand, is all the waste that occurs once the customer has received the food, essentially food that is left behind on consumer plates.

Minimal academic studies have actually sought to map food material flows in restaurants and quantify the source of food waste in restaurant systems – i.e. whether more food waste occurs pre- or post- consumption. The general consensus appears to be that the majority of food waste in restaurants generally occurs in the kitchen through preparation. A UK study by the Sustainable Restaurant Association (SRA) sought to provide a snapshot of food waste production in 10 different restaurants in the UK, along with the identified sources and causes (SRA, 2010). The SRA study involved surveying 10 restaurants in the UK and asking them to separate and weigh their food waste over one day according to source, being (1) preparation waste and any food ruined in cooking, (2) food classified as spoilage (e.g. out-of-date and unused items), and (3) customer plate waste. The researchers also collected data on the number of people served on the day in question. The waste audit was followed up by a survey where the SRA asked participants on the possible causes of food waste in their restaurants and what they do to reduce food waste. Using this methodology, the study found that the restaurants produced on average 59.8 kg of

food waste a day, or 0.48 kg of food was per customer served. Of this waste, 65 per cent came from preparation, 5 per cent was spoilage and 30 per cent came from customer's plates.

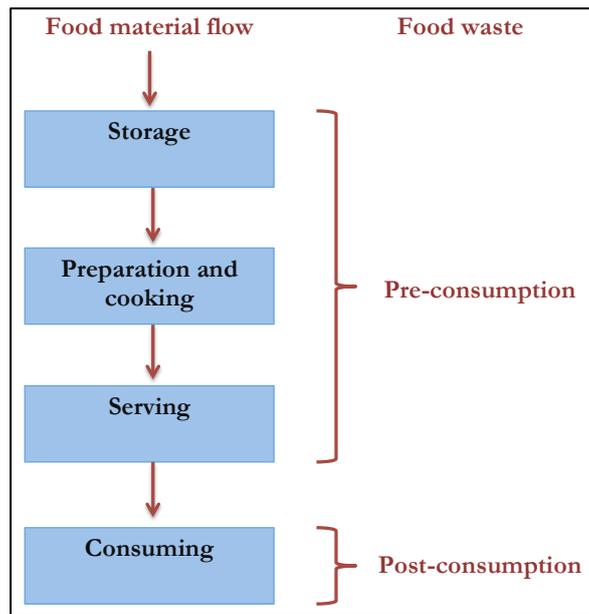
Figure 7 – MFA for findings of SRA study (source: author's own illustration based on SRA, 2010 findings)



The food waste source points that SRA identified (being customer, kitchen and spoiled) were also adopted by Unilever Food Solutions in its guidelines on minimizing food waste (Unilever Food Solutions, 2013). The Unilever guidelines suggest that restaurants follow the same approach used in the SRA study for measuring the quantity and source of food waste and thus assigning costs to food waste (Unilever Food Solutions, 2013). Unilever UK has also released a mobile phone application that enables restaurants to measure the quantity and source of food waste using this methodology, and estimate how much money they could save if they reduced 20 per cent of all their food waste each year. While this is a useful methodology for identifying the source of food waste in restaurants, there are two major limitations in using this methodology for QSRs. Firstly, it does not align with the UNFAO definitions of food waste, or global targets for reducing food waste, in that it considers both “avoidable” and “unavoidable” food waste as the same type of food waste. Costs are estimated based on all food waste, even though a proportion of food waste will always be unavoidable (also classified as inedible). Instead, the UNFAO and WRAP definitions of avoidability should be applied to any MFA, as per the recommendations by Norden (Nordic Council of Ministers, 2012). Secondly, and more specifically for QSRs, it only looks at three steps along the restaurant food chain, as opposed to all potential steps involved in the pre- and post- consumption stages of food material flow in restaurants previously discussed.

In normal restaurants, for example, we would not expect much cooked food to be wasted because food is generally made to order. The majority of cooked food that's wasted will be plate waste rather than pre-consumption waste. Rather, pre-consumption food waste would relate to preparation food waste, or food that has been damaged or spoiled in storage (as in the SRA and Unilever methodologies). QSRs, however, are characterized by their ability to serve people food quickly. As such, food is generally already cooked and ready to be served by the time it is ordered. We would therefore expect more food waste at the point between when the food is cooked and when the food is actually served due to cooked food “going off” or passing holding times specified in food health and safety guidelines before it can be served to customers. Additionally, in any restaurant system, it is important to understand whether food is wasted in the kitchen because it has spoiled in storage or for other reasons. If it spoils in storage, then measures would involve looking at the restaurant's storage system and methods. Figure 8 on the follow page perhaps provides a more comprehensive view of where food waste can arise within a QSR system.

Figure 8 – MFA and food waste source-points in QSRs



The studies identified also have not gone further to identify actual food waste material flows from the point of food input – i.e. what proportion of food is actually consumed in a restaurant compared to the proportion of food wasted. This information is helpful to put the quantity of food waste produced in to context, and to fully understand the extent of the food waste problem. It would also be necessary to produce Sankey diagrams, which help paint a more comprehensive picture of the problem. Knowing how much food is wasted is only one part of the story; it is also helpful to know how much food is actually consumed in order to better understand the proportion of food wasted versus food consumed. Only a small number of studies have actually sought to estimate the proportion of food consumed versus the proportion of food waste in restaurants. A commonly referred to estimate (from a 2005 US study) is that fast food restaurants waste 9.6 per cent of food, while normal full service restaurants waste 3.11 per cent. The same study found that fast food restaurant losses vary greatly depending on the size of the chain. The large fast food chains have much lower loss rate (5-7 per cent) compared to small local chains where loss rate can be as high as 50 per cent (Jones, 2005).

## 2.4 Food waste causes and prevention measures

### 2.4.1 Overview

Once the quantity and source of food waste in restaurants and QSRs has been identified through MFA and process mapping, it is easier to identify the cause and thus assign targeted measures for food waste prevention (i.e. through a closer look at the material flow balances and interpreting the process charts and material flows of the defined system). A number of studies have sought to identify food waste causes and best practice responses in restaurants. Most studies appear to be based more on qualitative research methodologies, such as surveys, interviews and observations by people in the industry. As explained, these measures can be used to support quantitative methodologies, like MFA, to identify the source and cause of food waste. Further, while best practice can be assumed in most cases, there is a real lack of studies monitoring the actual impact of measures on preventing food waste in restaurants (Nordic Council of Ministers, 2012).

Causes and prevention measures are predominantly identified in “grey” literature (such as best practice guidelines) with minimal academic studies being identified. Both academic and grey literature have identified that food waste causes and prevention measures can apply to all the

food waste produced in restaurants, while others can apply to specific points along the food material flow chain, and can be separated into pre- and post- consumption food waste causes and prevention measures. The following chapter discusses some of the main food waste causes and prevention measures highlighted in the literature.

Table 2 – Overview and examples of avoidable food waste causes and possible prevention measures identified in the literature

	Food waste causes	Possible measures
<b>General</b>	Lack of top management/employee awareness and support, lack of training.	Improve support through, for example, increased resource and financial commitment, increased employee awareness and training.
	Minimal measuring and monitoring of food waste.	Conduct regular food waste audits to better understand quantity and source of avoidable food waste. Communicate results and progress to employees.
	Minimal perceived financial benefits.	Ensure the costs of all food wasted in the kitchen are recorded daily. Understand the full costs of avoidable food waste from a preventative perspective. Calculate full costs of avoidable food waste through findings of the waste audit, disposal costs, and estimated proportion of food wasted.
	Strong focus on food waste management as opposed to prevention.	
<b>Pre-Consumption</b>	Preparation food waste through inexperience, failure to reuse.	Identify where kitchen waste can be reused internally, for example, through making soups or sauces.
	Poor forecasting or planning.	Implement thorough planning and forecasting procedures, including comprehensive storage procedures. Fully understand the legal situation regarding external redistribution of food waste to people or animals and redistribute where legal.
	Cooking too much food.	
	Technical limitations (e.g. poor refrigeration and cooking equipment).	Conduct regular maintenance checks on equipment, including cleaning, changing coils in the fridge and making sure fridges are properly sealed.
<b>Post-Consumption</b>	Excessive portion sizes.	Check portion sizes are appropriate by, for example, talking with customers and inspecting customer plate waste. Offer a range of portion sizes.
	Culture of customers.	Consider measures that align with company strategy. Educate customers to only take what they need and eat all the food on their plate, and of the environmental and social outcomes of food waste. Where possible, remove trays. Where legal, encourage the use of doggie bags. Avoid free meal size upgrades and “buy one get one free” type deals. Consider charging customers for plate waste (by weight, for example).
	Customer’s ordering too much/restaurants encouraging customers to over order.	
	Lack of customer awareness.	
Minimal perceived financial incentive by customers.		

## 2.4.2 All food waste

The total amount of pre- and post-consumption food waste a restaurant produces could be due to top management and employee attitudes towards (and awareness of) sustainability and food waste prevention; insufficient organization, monitoring and measuring of food waste; restaurants failing to recognize full cost pricing when it comes to the total costs of food waste to business; and the general acceptability of food waste management measures (reducing the need for prevention).

Food waste prevention requires clear commitment from top management and employees – whether it is financial or physical support. Support may be lacking due to a number of reasons, such as no perceived financial incentive for preventing food waste, a belief that food waste prevention is difficult and costly, an unwillingness to commit time or resources towards food waste prevention, or an adverse attitude to change. Support for food waste prevention measures may also be lacking due to logistical issues, such as high customer volumes, that restrict a restaurant's ability to focus strongly on food waste prevention. Primarily, if there is no perceived need to change and prevent food waste, for financial reasons or other, then restaurants will be happy to continue with the status quo. Support also goes hand-in-hand with employee training and awareness. If top management sees the need for food waste prevention, prevention measures could include training and educating employees on how to prevent food waste and the importance of preventing food waste both to the business bottom line and to the environment, assigning specific staff-members roles and responsibilities with regards to food waste; and keeping records of prevention measures and success factors.

Food waste prevention also requires a certain degree of organisation regarding the amount of food waste produced in restaurants, and the source and cause of food waste. Measuring and monitoring food waste by quantity and source is continuously highlighted as an important means towards food waste prevention (European Commission, 2011b; Gunders, 2012; LeanPath, undated; Nordic Council of Ministers, 2012). Separation and measurement of food waste can have a positive impact by making staff (and sometimes customers) aware of the amount of food waste they are generating, which in turn provokes efforts to reduce food waste (European Commission, 2011b). A US organization called LeanPath, which provides food waste monitoring and measuring services for restaurants, has identified that often the simple act of monitoring and measuring restaurant food waste can reduce its production and thus save money (LeanPath website, 2013). This is because it enables establishments to pinpoint exactly where waste is being produced and how much is being produced each day and thus set targets and benchmarks for the future. Eurest, an international catering company, saw a large improvement in food waste once it started monitoring and measuring how much food waste it produces in Sweden. Seeing how much food waste was produced (and where) helped the company identify action points for reducing both pre- and post-consumer waste – including informing guests about the amount of food waste produced each day and involving staff in reduction measures (Pre-waste, 2012). Measuring and monitoring food waste has also allowed Eurest to set food waste reduction targets over the next three years (Pre-waste, 2012).

Accurately measuring and monitoring food waste also enables restaurants to properly measure the full cost of food waste to business. Often restaurants may only consider the direct costs, such as the costs of waste disposal or the purchase costs of food that's wasted, and fail to consider the hidden costs, including the money spent on energy and water to prepare and cook food that's ultimately wasted, and staffing costs spent on food waste (SRA, 2010; WRAP, 2011; Environmental Protection Agency Ireland, 2010). When restaurants believe all they are paying for food waste is the costs of disposal, they do not realize the full financial benefits of reducing food waste in the first place, including the financial benefits associated with also reducing energy and

water consumption. As such, this could reduce the financial incentives associated with food waste prevention in general.

The Norden study also argued that companies may be overly focused on food waste management, which detracts from food waste prevention as a strategy in restaurants (Nordic Council of Ministers, 2012). This is highlighted by the fact that restaurant owners may even see food waste management as another money-making avenue, whereby food waste could eventually be sold to third parties to be used in anaerobic digestion or compost. While this isn't the case currently in the EU, restaurants making money off waste could become common ground as food waste management measures become more economically efficient and viable. In other words, restaurants may see that it is almost in their best interests financially to focus on food waste management as opposed to prevention.

### **2.4.3 Pre-consumption**

Pre-consumption food waste is driven internally by the actions of individual restaurants and employees and likely contributes to a large amount of all restaurant food waste. The SRA study, for example, found that the average UK restaurant produces 70 per cent of its food waste in the kitchen, and 65 per cent of this is through preparation and the remaining 5 per cent is through spoiled food (SRA, 2010). Failure to reuse foods in other recipes, inadequate and improper forecasting and planning, poor storage and cooking facilities, and inexperienced staff can all result in large amounts of pre-consumption food waste. Strict food health and safety regulations and laws regarding food redistribution can further exacerbate the generation of pre-consumption food waste.

The SRA study highlighted the importance of addressing food waste in preparation specifically, however, it did not identify how much preparation waste is avoidable and thus easily reduced. The study found that there may be certain methods or processes that employees could follow to reuse preparation food waste (including unavoidable food waste) thus reducing overall pre-consumption food waste, such as making marmalade out of orange peelings or fish cakes from tuna off-cuts (SRA, 2012). Other guidelines suggest that the experience/skills of restaurant workers may contribute towards preparation food waste, and suggest that food should be prepared off-site in the hands of experts where it is more efficient to do so – such as leaving butchers to trim meat (Environmental Protection Agency Ireland, 2010). The danger, of course, is the potential to move food waste from preparation up the food supply chain.

Forecasting and planning is a big issue when it comes to pre-consumption food waste and, if not done properly, can be a central cause of food waste in restaurants. The European Commission food waste study found that food waste in restaurants is closely linked to logistics, such as the difficulty in anticipating demand and habitual overstocking resulting in spoilage (Monier et al., 2010). Forecasting and planning is important and ensures that restaurants only order and hold stock that they will be able to sell before it passes its expiry date and becomes inedible. Forecasting and planning also helps restaurants predict how much food to prepare each day based on how much they think they will sell. Forecasting and planning is particularly important for highly perishable foods, such as vegetables (Environmental Protection Agency Ireland, 2010).

Forecasting and planning likely becomes an even bigger issue with QSRs due to the “ready-to-eat” nature of these establishments. QSRs rely on strict forecasting and planning to ensure they prepare and cook the exact amount of food each day. If they over forecast, they have to throw food out at the end of the day, but if they under forecast, they may not be able to satisfy the needs of customers. Some QSRs implement strict forecasting systems that can predict the exact amount of customers each day depending on a number of variables, such as the weather, time of day and season (see for example case studies in Nordic Council of Ministers, 2012 and the use of

the Trim Trax forecasting system). To improve logistics in restaurants generally, restaurants could also have more of an emphasis on fewer choices and higher quality. Stocking a large range of menu items daily inevitably leads to food waste (European Commission, 2011b).

Forecasting and planning is further exacerbated by legal requirements regarding food health and safety and food redistribution. Food health and safety regulations dictate when food can and cannot be served to customers in restaurants, and require food that can no longer be served due to health and safety reasons be disposed of. Of particular importance to QSRs are regulations around holding times for hot foods. If food is prepared and cooked but not sold, restaurants are required to dispose of it once the specific holding time has passed (for example, fries can only be held for 7 minutes before they have to be disposed of if not served). In fact, a US study estimated that health and safety holding times contributes towards 10 per cent of all food waste in restaurants (Gunders, 2012). Therefore, arguably, having strict rules on food health and safety generates more food waste than necessary (Nordic Council of Ministers, 2012). Food health and safety regulations also restrict the ability of restaurants in general to redistribute food to people or animals. A restaurant survey by Norden found that 16 per cent of participants felt that flexibility in food health and safety legislation was important for reducing restaurant food waste (Nordic Council of Ministers, 2012). The European Commission study also notes that national governments could consider relaxing legislative requirements to allow for more food redistribution (European Commission, 2011b).

There are also a range of technical causes and solutions to pre-consumption food waste in restaurants. Food might not be stored properly, or cold storage facilities may be inadequate or outdated, causing food to spoil or go off before its use-by date. Similarly, cooking equipment could be insufficient, causing food to be damaged or destroyed in cooking. Such problems might require a higher emphasis on technical investments, such as new refrigeration or cooking equipment, over simple housekeeping changes. There may also be habitual methods that employees follow, and which could also be actions of inexperienced employees, that cause food waste, such as not knowing how to cook or store food properly. These kinds of problems would require more of an emphasis on training staff about methods, procedures and protocols to minimize food waste.

The main causes of pre-consumption food waste in restaurants highlighted by the literature also align with the causes of food waste in households. Another study by WRAP on the causes and extent of household food waste in the UK found that the two main causes of food waste in households related to either preparing, cooking or serving too much food (some of which doesn't even make the plate), or poor planning and purchasing decisions resulting in food not being consumed in time (Quested & Johnson, 2009).

#### **2.4.4 Post-consumption**

Both internal and external forces drive post-consumption food waste in individual restaurants. Generally, post-consumption food waste is a combination of consumer attitudes and eating behaviours, and how restaurants respond to these attitudes and behaviours (i.e. by what restaurant staff serve to the customers). Similarly, post-consumption food waste can be reduced or prevented by either changing internal methods, such as reducing portion sizes or offering a range of portion sizes, or encouraging consumers to only order what they need and to eat all the food on their plate.

Literature commonly refers to excessive portion sizes as being the primary reason for post-consumption food waste. A study by WRAP, which involved interviewing consumers about their most recent eating-out experience, found that the main reason why consumers leave food behind on their plates is because they believe that the portion sizes were too big (WRAP, 2013). Of all

diners who left food on their plate, 41 per cent said it was because the portion size was too big. The European Commission also identified portion size as a key issue, and that the “one-size” approach taken by many restaurants is a major cause of food waste (Monier et al., 2010). Portion flexibility, and wider acceptance of portion flexibility by both staff and consumers, either by providing different size options or enabling customers to request smaller or larger portions when they order food, is a simple way to reduce post-consumption food waste (European Commission, 2011b). Restaurants could also actively work to better understand the wants and needs of their customers. This could involve identifying different foods that customer routinely leave behind on their plate and reducing those foods. Another extreme approach that has been taken by some restaurants around the world is to provide an incentive for customers to eat all their food by charging consumers for food they don’t eat (Jefferson, 2012). *Kylin Buffet*, a Chinese restaurant in London, charges customers a \$32 USD wastage fee if they take more food than they can eat from the buffet. *Wafu*, a Japanese restaurant in Australia, charges 30 per cent more to customers who don’t eat everything on their plate.

Large portion size is of course not the only reason why consumers leave behind plate waste – plate waste also depends on the eating behaviour of customers. The WRAP study identified that there was a difference between people who ate out for the social experience and people who ate out just to refuel (WRAP, 2013). Diners who ate out in restaurants, hotels and pubs were more likely to leave food on their plate than those who went to other venues, such as QSRs, where presumably they were more likely to be eating-out simply to refuel. The study also found that because meal leavers are more likely to want the full dining experience they will order more courses (starter, main and dessert) so are more likely to leave food behind, whereas none meal-leavers are more likely just to order a main course to satisfy their appetite.

The cultural of the particular customers may also dictate why food is left behind. In China, for example, restaurant food waste has found to be linked to cultural attitudes and behaviours towards food portion sizes. In China, it can be culturally unacceptable to eat all the food on your plate or to not serve enough food to your guests. Eating all the food on your plate or serving lots of food to your guests are both considered signs of affluence. One study found that students in a university cafeteria throw away one-third of every meal, and seldom take home leftovers because it’s “inconvenient” (Zhou, 2013). Similarly, the practice of taking leftovers home from restaurants is not universally accepted in many countries across the world, including some EU and all Scandinavian countries (Monier et al., 2010; Nordic Council of Ministers, 2011).

The way a particular restaurant is set up may also encourage and facilitate customers to order more food than they need. An example is tray-line restaurant systems. Some studies have found that removing the customer plate trays in student cafeterias has reduced the amount of food waste produced by up to 30 per cent. This is because students order less food when they can no longer carry plates on their tray (see Thiagarajah & Getty, 2013; Ingram, 2011). While changing the restaurant set-up or menu in a way that discourages consumers to order too much food is good in theory, it is not necessarily a realistic strategy for restaurants. Ultimately, restaurants set out to make a profit, and they can achieve this by selling as much food as possible to each customer. In this sense, strategies that target reducing the amount of food customers purchase in order to reduce waste may in fact conflict with this ultimate goal.

Finally, low consumer awareness of food waste and the social and environmental implications of food waste contributes towards customers leaving behind plate waste in restaurants (Monier et al., 2010). It depends on individual restaurants as to whether or not they want to specifically engage with customers on food waste and the need to reduce customer plate waste. This may be a controversial subject, and some restaurants may feel it is up to national and local bodies to provide educational campaigns. However, studies have found that customers are demanding

more openness and transparency when it comes to food waste. The Unilever World Menu Report found that 80 per cent of surveyed respondents in industrialised countries, and 87 per cent in developing countries, expressed concern about professional food waste (Unilever Food Solutions, 2011). Engaging consumers on food waste could be a food waste prevention strategy.

## 2.5 Cost of food waste in restaurants

### 2.5.1 Overview

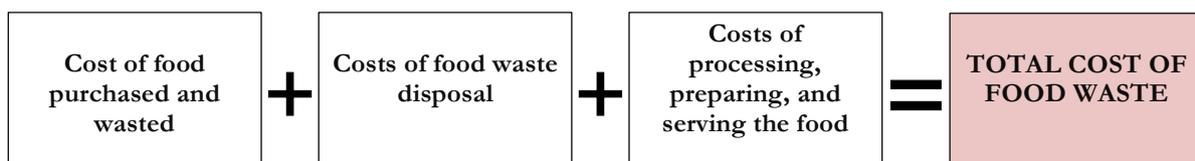
As previously explained, understanding the full cost of waste is central to any prevention strategies. It also helps provide financial incentives for minimising or preventing the production of waste in the first place. In the case of food waste, the costs include not only the costs of food waste disposal, but also the costs of purchasing food that's ultimately wasted, and the costs of preparing, processing and cooking food that's wasted (such as money spent on energy, labour and water). It has been estimated that restaurants pay around €2 per kg for the full costs of food waste produced, or around 2-10 per cent of turnover (Environmental Protection Agency Ireland, 2010; LeanPath, undated; SRA, 2010).

Both the WRAP and SRA studies provide good insights on how to calculate the costs of all food waste to individual restaurants and QSRs (WRAP, 2012; SRA, 2010). In both studies, the approach for quantifying costs of food waste in monetary terms was done from two perspectives:

- The costs of food purchased and then wasted; and
- The costs of food waste disposal.

A further third perspective of food waste costs could be calculated: the cost of processing, preparing and serving food that is ultimately wasted. This chapter will explore the application of all three perspectives in the case study.

*Figure 9 – The total cost of food waste in restaurants*



### 2.5.2 The costs of food purchased then wasted

Calculating the costs of food purchased by the restaurant and wasted (i.e. not consumed as intended) is based on the assumption that if you did not waste the food you wouldn't need to purchase the food in the first place. In its study on hospitality food waste, WRAP acknowledges that this is a simplistic approach – not all avoided food waste would avoid additional purchasing (for example, the calculations would include the weight of an orange and the inedible orange peelings). However, it was considered the best possible way to estimate the costs of food purchased and wasted (WRAP, 2012). WRAP and the SRA differed in their approach to calculating the costs of food purchased and wasted:

- **WRAP, 2012:** The cost of food purchased and wasted was based on the average cost of a tonne of food purchased by restaurants. WRAP estimated that average cost of a tonne of commercial food purchased by restaurants was £1,708 (€2,415).<sup>6</sup> WRAP then made an

<sup>6</sup> No published information was available on the commercial cost of a tonne of food for hospitality. Instead, this estimate was based on the published information on the average cost of a tonne of school cafeteria food and a tonne of household food.

assumption that food cooked and wasted weighs the same as when purchased, meaning that costs could be based on the weight of food wasted.

- **SRA, 2010:** The cost of food purchased and wasted was based on a proportion of the restaurant's total turnover. SRA estimated that food purchased and wasted amounts to around 2-3 per cent of a restaurant's turnover. A US-based agency called LeanPath takes a similar methodology to the SRA study, however, suggests that the cost of pre-consumption food waste is around 4-10 per cent of the total purchase price of food (LeanPath, undated).

There are limitations in both of these approaches. Neither of these calculations takes into account the fact that a proportion of food that is wasted is unavoidable, for example vegetable peelings and eggshells. The WRAP study estimated cost for a tonne of hospitality food is not based on any studies or primary data, and may not reflect the actual cost of a tonne of commercial hospitality food. Additionally, the WRAP methodology assumes that the food weighs the same before and after it is cooked, which is not often the case. Sauces, for example, may arrive in a powder form with water added in preparation, which would substantially increase the weight of the sauce.

The SRA and LeanPath approaches are probably more reliable and likely reflect the actual costs paid by restaurants to purchase food. However, they appear to primarily focus on pre-consumption food waste and exclude post-consumption food waste. While the cost of this food waste has been ultimately passed on to the consumer at the point of purchase, it should still be considered relevant because, particularly if portion sizes are too big, money could be saved by not serving too much food in the first place. Further, SRA and LeanPath differ in the proportion of costs attributable to waste, ranging from 2-10 per cent of turnover.

The best approach for individual restaurants would probably be to calculate the actual costs spent on the food that is wasted. This would require restaurants having an internal recording system whereby the purchase cost of food lost in the kitchen is adequately recorded as a total value and as a portion of turnover (for comparability) (Nordic Council of Ministers, 2011). Again, this would exclude the costs of post-consumption food waste, however, using the same methodology to calculate post-consumption food waste would require measuring and understanding the type and proportions of food waste produced and the purchase price of that food waste, which is much more complicated and has the potential to be inconsistent.

### **2.5.3 The costs of processing, preparing and cooking food that's wasted**

The cost of processing, preparing and cooking food that is wasted includes money spent on electricity, water and staff. It is difficult to accurately calculate these costs, which is why only minimal studies and guidelines have identified ways in which it can be done. Calculating these costs is particularly hard given different kinds of food each require different degrees of energy and water use, and labour. Further, food can be wasted at various source-points with varying degrees of preparation and cooking – some food might be wasted in storage, meaning only the electricity used in the refrigerator attributable to that particular food is wasted, whereas some food might be wasted after it has been prepared and cooked, meaning all energy and water used to get it to that point was ultimately wasted. Therefore, not all food wasted in a restaurant will have the same amount of imbedded energy and water consumption or labour resources.

The most referenced way of calculating the costs of processing, preparing and cooking food that is wasted is by estimating the weight proportion of food wasted against the proportion of food actually consumed and then applying this proportion to the total usage and costs of electricity, water and staffing (Environmental Protection Agency Ireland, 2010). There are some limitations in using this methodology. First, it is unlikely restaurants will have a record of the weight of food

wasted and food consumed, particularly when it comes to food purchased and wasted in the kitchen. Rather, food purchased would be recorded as the item or ingredient type and the cost. Second, this methodology assumes that all electricity and water used in the restaurant is for processing, preparing and cooking food, and whereas a portion of electricity and water could be used for auxiliary purposes, such as heating, lighting and flushing toilets. Third, as already discussed, the methodology does not take into account the fact that each item of food wasted in a restaurant will be at a different stage in the restaurant system and thus would use varying amounts of energy and water. Further, items of food differ in the amount of water, energy and resources required to make the food onsite. For example, cooking fries might require a much higher level of energy than assembling sandwiches.

To address the first point, restaurants could make estimations about the total weight of food intended for human consumption, weigh and record the total amount of food waste produced, and then compare the two measurements. Estimations could be based on, for example, visual estimations on the proportion of food wasted by customers versus consumed or assumptions on the weight of the average item compared to the actual weight of food wasted. As for the second point, total costs could be adjusted to any known and estimated proportions on electricity and water uses in the restaurant. For example, if it is estimated that 20 per cent of water is used in the bathroom and 80 per cent in the kitchen, the costs attributable to waste could be adjusted 80 per cent. However, no studies were identified that actually used this approach. This is possibly because it is difficult to draw the line between food activities and non-food activities.

The final two points will likely always remain a limitation in this approach. Addressing these limitations would require much more complex calculations and understandings of the energy and water consumption of different types of food, and understanding what types of food are wasted in a restaurant system and where in the process they are wasted. Doing this would involve a thorough food waste audit, including measurements of food by actual food items wasted and where in the system they are wasted – this may be extremely time consuming and have a large margin for error, and as such, will not be tried in this current study. However, it is still considered that the methodology is applicable for making estimations as to these costs, and providing a general indication of how much these costs could be for restaurants.

#### **2.5.4 The costs of food waste disposal**

Calculating the costs of food waste disposal depends on the means of disposal. In certain parts of the EU, for example, the costs could differ between food waste collected for anaerobic digestion and food waste sent to landfill. In both the SRA and WRAP studies, the costs of food waste disposal were the costs for either disposal by anaerobic digestion or sending the food waste to landfill. In both instances, costs were based on the weight of food waste produced and collected. For individual restaurants, the best approach would be to look at actual costs by weight.

#### **2.5.5 The costs of avoidable food waste**

A combination of the methodologies outlined above could be used to calculate the total costs of food waste produced in QSRs. The costs could be further calculated to account for the fact that only a proportion of food wasted is avoidable food waste (constituting costs that could be avoided). The costs attributable to avoidable food waste could be calculated by applying the proportion of avoidable food waste to the total costs. Only the WRAP study specifically distinguished between the costs associated with avoidable and unavoidable food waste using this approach (WRAP, 2012).

## 2.6 Analysing food waste in QSRs

The literature analysis suggests there are a few main focus points when it comes to analysing food waste prevention in restaurants and specifically QSRs. The literature analysis highlighted the importance of:

- Defining food waste. Food waste should be defined in a way that aligns with the UNFAO and WRAP definitions of avoidable and unavoidable food waste. Distinguishing avoidable and unavoidable food waste is important because it shows how much food waste could realistically be prevented.
- Measuring and monitoring food waste in a way that is comparable, both internally and externally. The most appropriate method appears to be measuring food waste as a total amount and compared to the number of customers served and/or the number of employees. Consistent measuring enables restaurants to benchmark and set targets internally and compare performance with other similar restaurants.
- Process mapping food waste material flows to identify food waste hot spots. Process maps should identify all food waste source-points within a restaurant system and measure the amounts and proportion of food waste produced at each source point, including avoidable food waste.
- Adequate forecasting and planning systems to avoid having to throw food out as a result of over-preparing, particularly in QSRs. This is further exacerbated by legal restrictions on food health and safety and food redistribution to people or animals, which is a policy-making matter and essentially out of the hands of individual restaurants.
- Portion sizing and understanding customer needs. Post-consumption food waste can be reduced through better portion sizing and providing the customer with the types of foods they want. This could include observing the types of food that come in on customer plates and adjusting the menu accordingly.
- Keeping a record of and monitoring the full cost of food waste. Costs should be calculated based on purchase costs of food wasted, disposal costs and the costs of preparing and cooking food. It is, however, difficult to calculate the exact costs of processing, preparing and cooking food that's wasted and, as such, there will likely be a margin of error. Keeping a daily record of the cost of post-consumption food waste is particularly important for this equation.

The literature analysis also suggests that food waste sources and causes may be different in QSRs when compared to normal restaurants. In particular, inaccurate forecasting and planning has the potential to cause a large amount of food waste in QSRs due to the “ready-to-eat” nature of QSRs. Also, as a large amount of food waste is prepared off-site in QSRs, it is unlikely QSRs will produce as much onsite preparation food waste as normal restaurants.

## 3 Case Study

### 3.1 Background

The four case study restaurants are part of a QSR restaurant chain that operates over 300 restaurants globally, giving it the scope to reduce food waste on a global scale. The restaurant chain itself is part of a wider department store brand and is complementary to the company's main purpose, which is to sell furnishings. As such, all restaurants in the chain are located within the department store. The restaurant chain has been classified as a QSR for the purposes of this study because it is characterized by fast food cuisine and minimal table service. The restaurant chain could be further classified as a sub-set of QSRs, being "fast casual restaurants". Fast casual restaurants differ slightly from traditional QSRs in that, while they still offer fast food, the food and atmosphere is considered a higher quality than traditional QSRs. Fast casual restaurants also have much higher eat-in ratios than traditional QSRs.

The main premise of the restaurant chain is to "offer great quality food at the lowest prices" (Internal Food and Beverage Manual, 2012; p15). In this sense, the brand concept is based on serving high volumes at low prices that can be achieved through economies of scale without compromising on "quality, environmental aspects or the health and safety of anyone included in the supply chain" (Internal Food and Beverage Manual, 2012; p20). The restaurant chain is trying to become more sustainable in the future and, as part of this, has set targets for water and energy use reduction by 2025. In this sense, reducing food waste is seen as a trigger point to also reduce energy and water use associated with wasted food. The restaurant chain is also mindful of the general global need to reduce food waste for environmental and social reasons.

Each restaurant within the chain (including those studied) consists of both a customer and staff restaurant. The customer restaurant serves all customers that come into the department store, while the staff restaurant serves all staff working both in food and beverage and in the department store. For stores that are attached to national head offices, the restaurant also serves all head office staff and visitors. The two restaurant systems are largely separate – they often have their own kitchen, and separate serving and eating areas, but they share a dishwashing room, a waste room and storage facilities.

### 3.2 Introduction to the case studies

Four restaurants within the same QSR chain have been analysed. The two Europe restaurants (Europe A and B) are considered the "high performing" restaurants within the case study because they produce comparatively lower amounts of food waste. Europe A is located next to the company headquarters, meaning the staff restaurant services all head office staff and visitors. It is the concept store for all restaurants within the QSR chain, so it should provide a good example of best practice and benchmark for other stores to follow. It is also the store where new ideas and technology is tested before being shared with other stores within the chain. Europe B has much smaller volumes given it does not serve head office staff in the staff restaurant, however, it also produces a low amount of food waste. It is located in a different but similar European country to Europe A.

The two Chinese restaurants (China A and B) are considered the "lower performing" restaurants because they produce substantially more food waste than the European restaurants. These restaurants are, however, important to the QSR chain because China is a major growth area for the company over the next ten years. China A is one of the major restaurants in China and is located next to the China head office in central Shanghai. It has been operating for around 10 years, and is one of the biggest restaurants in the chain in terms of volume. China B, however, is

located on the suburban rural outskirts of Shanghai. It is only 2 years old, and is much smaller in size volume.

Table 3 – Overview of case study restaurants, including size, number of employees, customer tickets and items sold daily

	Europe A			Europe B			China A	China B
	Cust	Staff	Total	Cust	Staff	Total		
<b>Floor size</b>	1,338m <sup>3</sup>	365m <sup>3</sup>	1,703m <sup>3</sup>	-	-	~1,200 m <sup>3</sup>	2,480 m <sup>3</sup>	1,904 m <sup>3</sup>
<b>Total no. Employees</b>	77	13	90	~70	~10	~80	~70	~40
<b>Customer tickets</b>	1,668	596	2,264	1,155	61	1,216	3,806	2,005
<b>Items sold</b>	8,996	2,044	11,040	4,658	71	4,729	14,555	9,533
<b>Items per customer</b>	5.4	3.4	4.9	4.0	1.2	3.9	3.8	4.8

**Notes:**

Each customer ticket represents on average 2.2 people in the customer restaurant and 1 person in the staff restaurant (Food and Beverage Specialist, June 2013).

The floor size for Europe B was unable to be obtained so the total floor size has been estimated in comparison with Europe A.

The daily employee number for Europe B is based estimations provided by the restaurant and may not be entirely accurate.

Source: Daily sales report for Europe A and B, yearly sales reports for China A and B (2012/13)

### 3.3 Description of the restaurant systems

#### 3.3.1 Customer restaurant

The customer restaurant is the main restaurant system and generally serves at least six times the number of customers served in the staff restaurant. The customer restaurant serves 50 per cent western standardized menu items and 50 per cent locally adapted items. In China, this generally means rice and vegetable or meat dishes, Chinese soups and so on. The western standardized menu items are characterised by around 90 per cent off-site food preparation and most food arrives to the restaurant prepared or pre-cut (Food and Beverage Specialist, June 2013). Preparation in the kitchen largely involves re-heating and assembling food, as opposed to chopping, peeling and mixing. The customer restaurant has a tray-line serving system offering self-serve cold items and served buffet-style hot meals. Customers in the restaurant predominantly eat in and are requested to clear the tables and place trays either on a trolley (in China) or conveyor belt (in Europe A). In Europe B, customers are requested to pre-sort tray waste before placing tray on the conveyor belt.

Picture 1 – Example of pre-prepared tomatoes, cucumber and onions: Europe A



Picture 2 – Example of food waste trolley in customer restaurant in China



### 3.3.2 Staff restaurant

The staff restaurant is characterized by more local meals, which generally means a higher degree of on-site preparation and local ingredients. Meals in the staff restaurant differ to the customer restaurant and are adapted depending on the local needs of the staff. The staff restaurant also offers meals at substantially reduced prices compared to the customer restaurant. The staff restaurant has a tray-line serving system but with a higher degree of buffet style self-service. In Europe, staff are offered two hot-meal options with standard serving sizes displayed on the counter. In China, staff are offered a generic Chinese food buffet with a range of hot food options. Staff are also requested to clear their tables. In all restaurants but China A, staff are requested to sort their tray waste into food and residual waste components. In China B, food waste collected in the staff restaurant is even weighed and recorded daily, and communicated to staff. In China A, staff put their trays directly on a trolley.

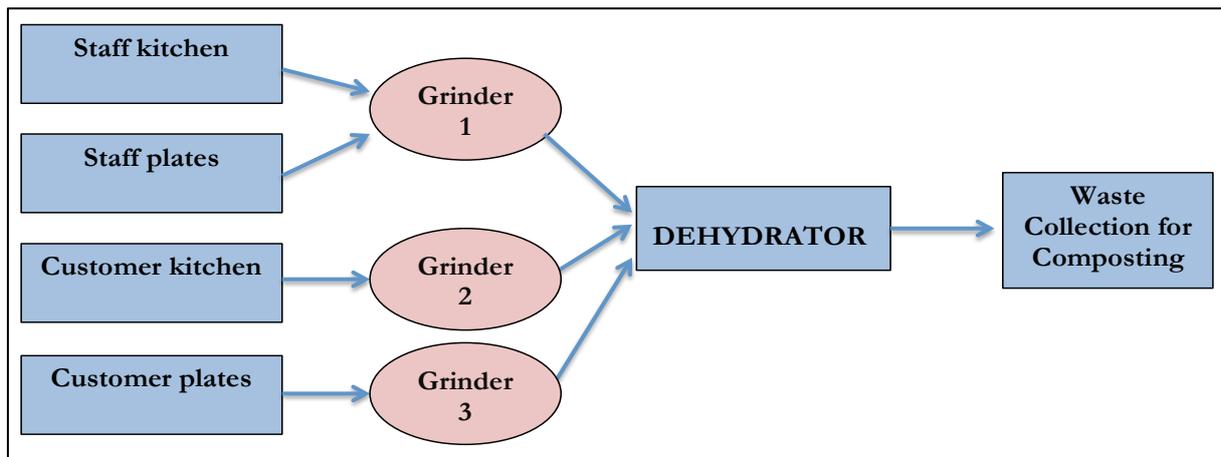
## 3.4 Material Flow Analysis

### 3.4.1 Food material flow

For all restaurants, food essentially goes through four major steps: (1) storage, (2) preparation and cooking, (3) serving and (4) consuming. Storage involves holding the food in cold storage until it is ready to progress into the next steps. Preparation and cooking generally involves assembling pre-prepared ingredients and/or reheating or cooking ingredients or meals. Serving involves both cold and hot serving. Cold serving is when food is held in a cold cabinet in the serving line, and hot serving involves a buffet-style service from hot trays. The final stage is obviously when food gets consumed by the customer. Food waste can occur at any stage along this process.

The food waste system, particularly with regards to food waste management, is different in Europe A than in the other restaurants. Europe A is currently trialling a food waste dewaterer. In Europe A, once food waste is produced, it is separated at source and fed into one of three separate food grinders. The food grinders reduce the volume and size of the food and pump it in to an onsite dewaterer. The dewaterer, through a centrifugal system, removes 30 per cent of the weight of the food waste (being the water component), before the municipality collects it either for composting or anaerobic digestion. Water is then discharged through the waste water system.

Figure 10 – Food waste sorting in Europe A



In Europe B, all food waste is sorted at source. Customers in both the customer and staff restaurant are also requested to sort their waste into food and residual waste fractions. The municipality then collects the separated food waste for either composting or anaerobic digestion.

There are food waste-sorting systems in the Chinese restaurants; however, it isn't entirely clear whether these systems are being strictly followed (often non-food items, such as napkins, were observed inside the food bins and staff advised that the company receiving the waste can sort out the non-food items). In China B there is, however, a strong emphasis on food waste sorting in the staff restaurant. In both restaurants, it is unclear what happens to food waste once the municipality collects it. In China A, it is possible that the food is either composted or turned into animal feed. In China B, the most likely outcome is that food waste goes to the landfill.

### 3.4.2 Waste quantity

Each of the four different restaurants studied were found to have quite different food waste characteristics and varying amounts of food waste produced per customer ticket and per employee. This information is provided in Table 4.

Table 4 – Daily (estimated or actual) amount of food waste produced in case study restaurants (in kg)

	Europe A			Europe B			China A	China B
	Cust	Staff	Total	Cust	Staff	Total		
<b>Total waste</b>	102	55	157	71	31	102	1500	400
<b>Waste per customer ticket</b>	0.06	0.09	0.07	0.06	0.5	0.08	0.4	0.2
<b>Waste per employee</b>	1.3	4.2	1.7	~1.0	~3.07	~1.3	21	10

#### Notes:

Europe total waste based on actual on-site measurements for one day.

China total waste based on estimations made by interviewees and on-site observations.

### 3.4.3 Waste source

The MFA identified different food waste source profiles across the case study restaurants. The following table shows the amount and proportion of food waste produced at each different source point in the food chain per day (actual for Europe and estimated for China).

Table 5 – The (estimated and actual) amount and proportion of food waste produced in storage, preparation/cooking, serving and consuming, for the different case study restaurants (in kg)

Food material flow	Europe A		Europe B		China A	China B
	Cust	Staff	Cust	Staff		
Storage	0.5 (0.5%)	0 (0%)	6.8 (9.6%)	0 (0%)		
Preparation and cooking	3.7 (3.5%)	0 (0%)	9.5 (13.4%)	3.6 (11.7%)	150 (10%)	40 (10%)
Serving	67.5 (66%)	40.8 (74.2%)	4.5 (6.4%)	12.6 (41%)		
Consuming	30.3 (30%)	14.2 (25.8%)	50 (70.6%)	14.5 (47.2%)	1350 (90%)	360 (90%)
Total food waste	102 (100%)	55 (100%)	70.8 (100%)	30.7 (100%)	1500 (100%)	400 (100%)

### 3.4.4 Avoidable food waste

As above, visual estimations were made on the weight proportion of avoidable and unavoidable food waste in all four restaurants in Europe A and B, these estimations could be made at all four source points through the waste audit. In Europe A, 9 per cent of food waste produced across both the customer and staff restaurants was estimated to be “unavoidable” food waste, such as vegetable peelings, eggshells and bones. Unavoidable food waste was produced in both the preparation and consumption stages of the food chain. In the customer restaurant, 10 per cent of food waste on customer plates was classified as unavoidable, whereas in the staff restaurant, 40 per cent was unavoidable. All food waste produced in preparation was classified as unavoidable. All food waste produced in serving was classified as avoidable. In Europe B, 25 per cent of food waste produced across both restaurants was estimated to be “unavoidable” food waste. All food waste produced in preparation was classified as unavoidable in both the staff and customer kitchens. Around 20 per cent of plate waste in the customer restaurant was classified unavoidable and around 80 per cent of plate waste in the staff restaurant was unavoidable. All food waste produced in serving and storage was classified as avoidable.

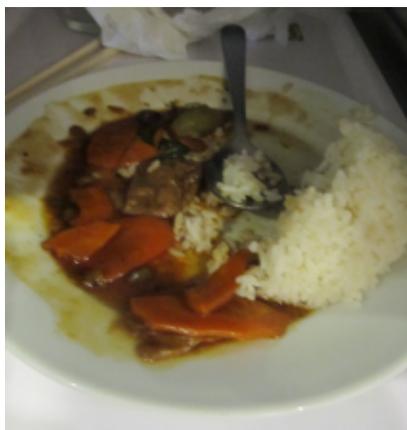
In China, as explained in the methodology, food waste avoidability could only be estimated based on (1) a visual estimate through 2-hour snapshot survey of customer plate waste in China B, and (2) estimations provided by employees. Through this method it was estimated that in China A, around 27 per cent of food waste was “unavoidable” food waste. Around 20 per cent post-consumption food waste was estimated to be unavoidable and 90 per cent of pre-consumption food waste was unavoidable. Pre-consumption avoidable food waste generally consisted of rice in the serving stage, while post-consumption avoidable food waste was a mix of all foods served,

with a large proportion of rice. Pre-consumption unavoidable food waste generally consisted of vegetable peelings and off-cuts resulting from preparing and cooking the local menu items.

Table 6 – Estimated proportion of avoidable and unavoidable food waste

	Europe A	Europe B	China A&B
Avoidable	91 %	75 %	73 %
Unavoidable	9 %	25 %	27 %

Picture 3 – Example plate waste: China A



Picture 4 – Example waste from multiple plates: Europe A



Picture 5 – Example preparation and storage waste: Europe A



### 3.4.5 Weight proportion of food wasted

Rough estimations were made about the weight proportion of food consumed against food wasted in each restaurant studied to fully understand how much food is wasted in each restaurant and to develop Sankey diagrams. The estimations were based on rough estimations as to the average weight of solid food per customer ticket in each restaurant (based on the average number of items per customer ticket and the average weight of meals), the total number of customer tickets per day, and the total amount of pre- and post-consumption waste produced per day. The assumptions and calculations for each restaurant are further explained in the Appendix.

Through this methodology, it was estimated that (by weight) around 8 per cent of food intended for human consumption was wasted daily in Europe A, 13 per cent in Europe B, 35 per cent was wasted in China A and 18 per cent was wasted in China B. Figures 11 and 12 provide the developed Sankey diagrams for each restaurant studied, in order to further highlight the “hot spots” in each restaurant.

Figure 11 - Sankey diagrams for estimated food waste material flows in the European restaurants

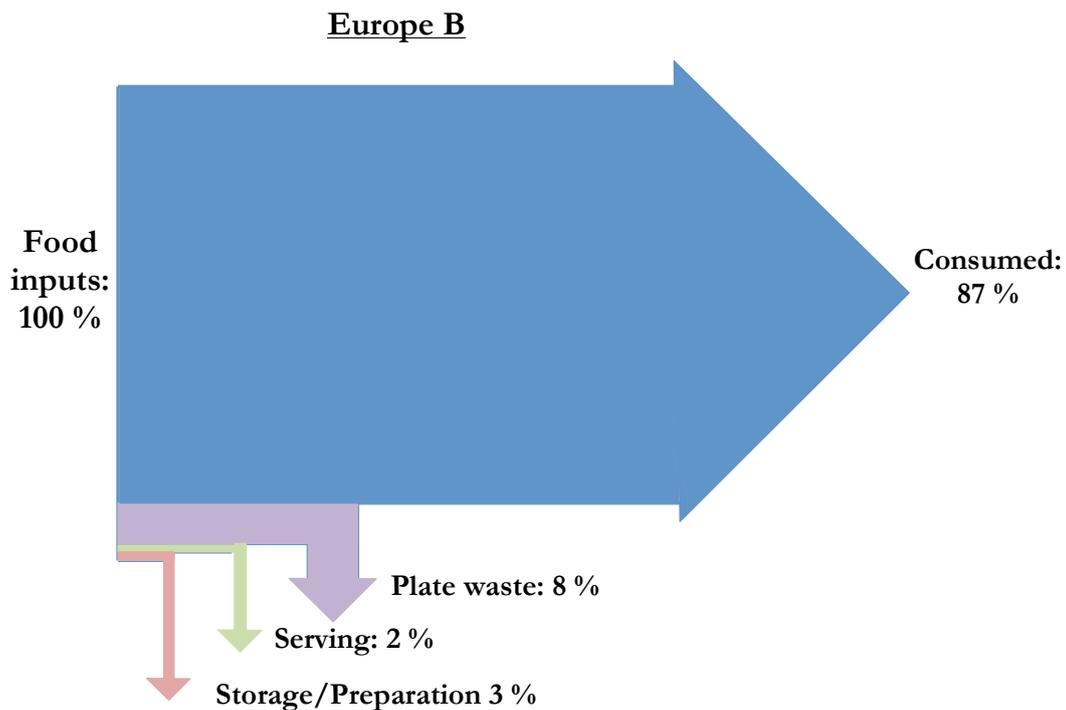
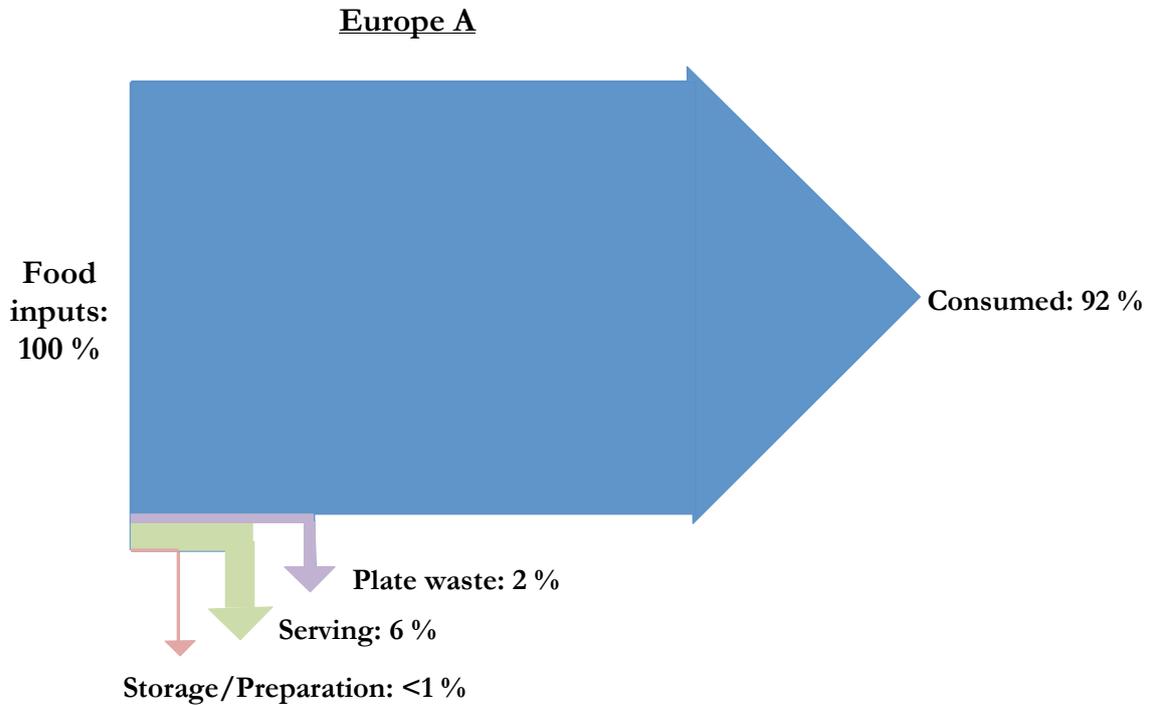
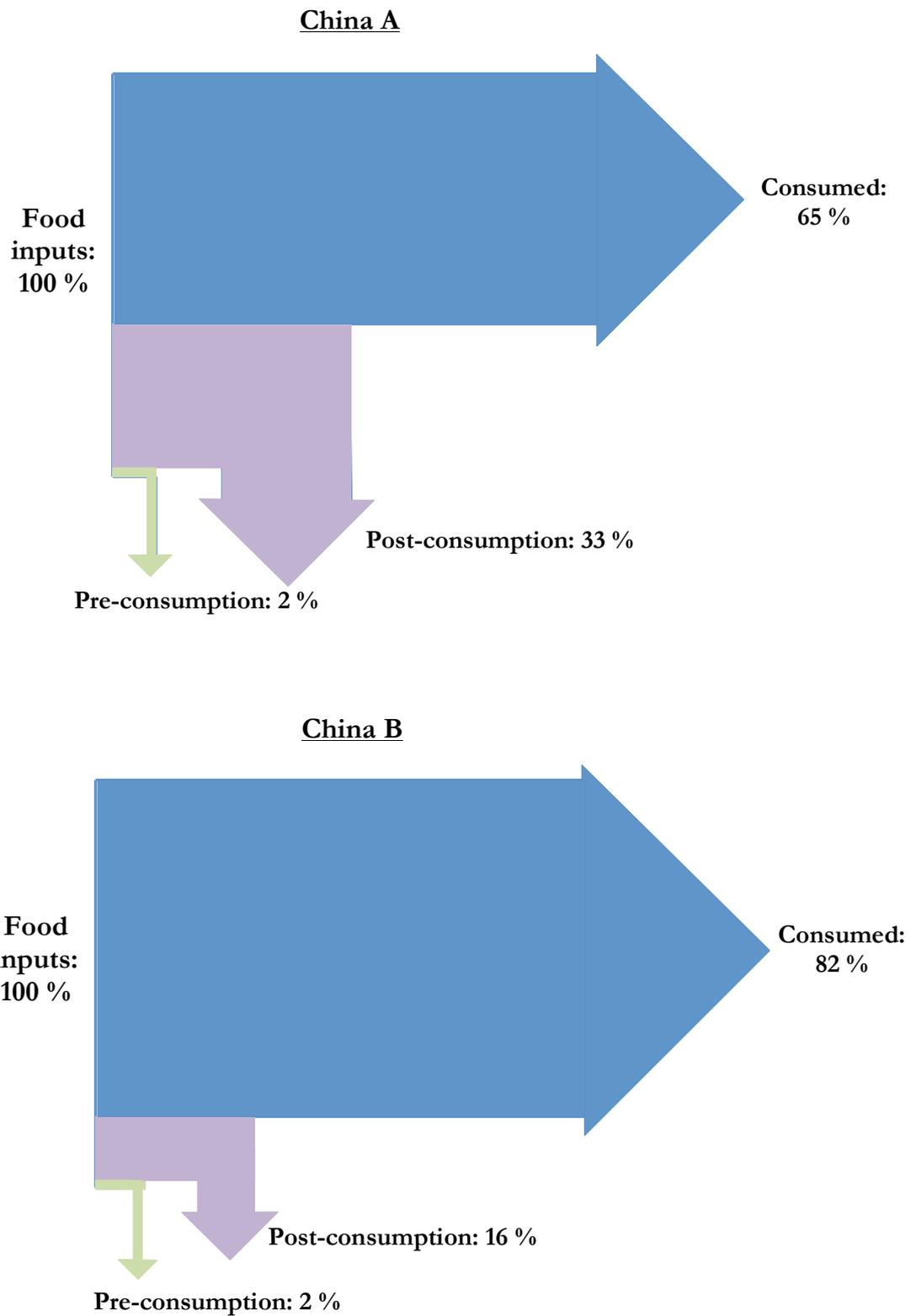


Figure 12 – Sankey diagrams for food waste material flow in the Chinese restaurants



## 3.5 Factors affecting food waste

### 3.5.1 General

While the restaurant chain views sustainability as a major issue for the future, food waste is not specifically identified as a big issue, other than the energy and water wastage as a result of food waste. Food waste prevention as a sustainability issue does not appear to be considered a major concern by top management and restaurant employees. Food waste prevention measures are instead targeted at minimizing losses and maximizing profits rather than on any specific sustainability or environmentally motivated outcome. Further, none of the restaurants appeared to have any specific employees with assigned responsibilities with regards to food waste prevention, and there is no cohesion between food waste, energy and water, with various people holding necessary information. Each store has a sustainability specialist, and the general approach appeared to be that employees believed the sustainability specialist had specific oversight of food waste and associated energy and water consumption, when in fact the sustainability specialist rather focussed on corporate social responsibility (CSR) and managing waste contracts. In China in particular, one of the sustainability specialists had no oversight of energy and water consumption, and waste, believing his job revolved entirely around CSR.

Europe A is trying new initiatives when it comes to the use of the dewaterer; however, again this is largely seen as a money-saving initiative. It is also seen as a solution to minimizing food waste, but it does not actually prevent food from being wasted in the first place. For example, one of the kitchen staff in Europe A questioned food waste prevention in general, saying that all food waste reduces in size anyway once it goes through the dewaterer so does not need to be measured by source. This might indicate that because Europe A has a strong focus on food waste management the focus has shifted away from food waste prevention. Similarly, the Chinese restaurants have an internal goal of diverting all food waste from landfills to composting, biogas or animal feed. While this is an excellent initiative, and probably above other restaurant initiatives in China, it still shows a primary focus on food waste management as opposed to prevention.

Similarly, none of the restaurants monitored and measuring food waste throughout the store. Food waste measuring is limited to recording the costs of avoidable pre-consumption food waste – i.e. essentially food wasted either in storage or serving. Only Europe A and B could actually point to waste figures in a weight amount, while the Chinese stores each pay set amounts for waste disposal and thus do not record the actual amount of food waste produced each day in terms of weight. Rather, the amount of food waste produced in the Chinese restaurants is based on estimations provided by staff. China B recently did start recording the weight of food waste produced in the staff restaurant – however, this was not compared to the number of customer tickets or items sold, making it hard to benchmark and ascertain progress. Similarly, none of the stores had food waste reduction targets, baselines or benchmarks, nor anyway of evaluating such targets, baselines or benchmarks.

Recently, the company published internal guidelines on how chain restaurants should minimize on-site food waste. The guidelines provide some very good insights on reducing food waste on-site, including monitoring and measuring food waste, adjusting portion sizes, and monitoring the types of plate waste produced. However, the guidelines had not been translated into Mandarin at the time of the study, so the Chinese restaurants had not seen the guidelines previously. It was also unclear whether the European restaurants were specifically following the guidelines with regards to food waste prevention, especially given they still do not measure and monitor food waste. It may be too early for the restaurants to have effectively made any changes recommended in the guidelines.

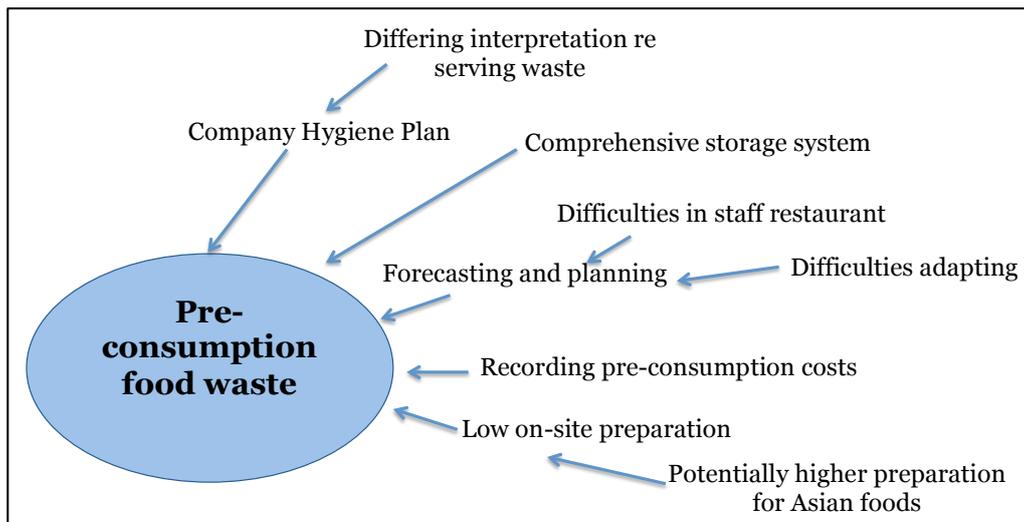
Table 7 – Overview of identified factors affecting food waste production in the four restaurants studied

	Europe A	Europe B	China A	China B
<b>General</b>	Lack of top management and employee support, lack of organisation when it comes to food waste prevention measures, and monitoring food waste, and associated energy and water consumption.			
	No measuring and monitoring food waste.			Some monitoring and measuring in staff restaurant
	Food waste prevention guidelines (but not strictly followed).			
	Predominant focus on food waste management.	Focus on prevention as well as management.	Predominant focus on food waste management, but still high focus on pre-consumption prevention.	
<b>Pre-consumption</b>	Strict interpretation of Company Hygiene Plan.	Potentially loose interpretation of Company Hygiene Plan.		
	Thorough recording of food waste costs.		Potentially loose recording of food waste costs.	
	Comprehensive storage procedures.			
	Comprehensive forecasting and planning systems.			
	Need to be able to serve all customers quickly.			
	Observed difficulty forecasting in staff restaurant.			
	Observed failure to adapt forecasting throughout the day.			
	Low preparation food waste because 90 per cent off-site preparation.		Potentially higher on-site preparation associated with Asian cooking.	
	High proportion of food waste “avoidable” and produced in the serving line.		High proportion (around 90 per cent) of food waste “unavoidable”	
	Strict approach to reusing kitchen food.	System of internal food reuse and identifying synergies between customer and staff restaurants.		
<b>Post-consumption</b>	Accurate portion sizes.	Potentially excessive portion sizes.	Excessive portion sizes.	
	Potentially high consumer awareness.		Culture of Chinese customers- more prominent in urban China A.	
	High proportion (around 80 per cent) of food waste “avoidable”.			

### 3.5.2 Pre-consumption

All four restaurants studied focus on preventing pre-consumption food waste in order to reduce cost and minimize waste in the kitchen. The major factors identified that affect pre-consumption waste in all restaurants are the Company Hygiene Plan (and potentially differing responses to the Plan amongst the restaurants when it comes to serving waste), comprehensive storage procedures, forecasting and planning systems and the difficulty of adapting during the day; difficulties in forecasting in the staff restaurants; recording the costs of pre-consumption food waste; a higher degree of unavoidable food waste in preparation in China due to the style of Asian cooking generally (in that it requires a higher degree of preparation than Western cooking).

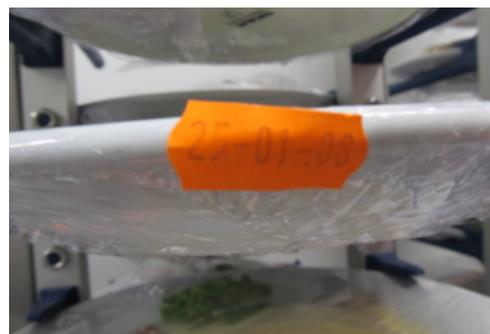
Figure 13 – Factors contributing towards pre-consumption food waste in case study QSRs



The company has its own internal food safety guidelines, which specify procedures and protocols that must be followed by all restaurants for purchasing and receiving ingredients and products; storing food; processing and preparation of hot and cold foods; chilling prepared foods; serving foods from the buffet and chilled display counters; training staff; and record keeping (the Company Hygiene Plan, 2010). The processes and procedures are designed to minimize the amount of food that is wasted in the kitchen by ensuring it is properly stored, prepared and served. The food safety requirements in the guidelines align with the Dutch food health and safety regulations. The Dutch regulations are stricter than most other national regulations, meaning restaurants generally have to apply stricter measures with regards to food health and safety than local legislation requires (Food and Beverages Specialist, June 2013). If, however, local regulations are stricter than the company guidelines, restaurants are required to follow local regulations instead of the guidelines.

One of the major aspects of the guidelines involves storage procedures. To adhere to the guidelines, all restaurants studied had clearly defined labelling systems for stored food. Food is labelled based on when it is taken out of the freezer, how long it has been in storage, when it needs to be used by and so on. Labels are colour coordinated to ensure foods are not missed. If food in the customer kitchen is approaching its use-by date and will not be consumed, consideration is given as to whether it can instead be legally sold in the staff restaurant (often at a reduced price or offered for free). The fact that such little amount of food is wasted in storage across all restaurants is a testament to these storage and classification systems.

Picture 6 – Examples of food labelling system: Europe A



All restaurants studied also have comprehensive forecasting and planning systems, which is particularly important when it comes to holding times. The forecasting and planning systems ensure the restaurants do not have to throw out too much food at the end of the day, particularly when it comes to holding times of food in the serving line. Europe A's forecasting and planning system is generally within 3 per cent of actual daily sales (Food and Beverage Manager, June 2013). The system helps kitchen staff plan how many hot and cold meals to prepare each day, when food should come out of cold storage and so on. In doing so, the forecasting system helps keep pre-consumption food waste to a minimum, particularly when it comes to serving food waste – i.e. the food that has been heated and is ready to serve to customers. When forecasting is off, this results in a large amount of pre-consumption food needing to be discarded at the serving stage, often at the end of the day. This is because, according to the food health and safety guidelines, once food is heated and ready to be served, it can only be held in the serving dishes for a certain amount of time before it has to be discarded (for example, fries can only be held for 7 minutes).

On the day of the waste audit in Europe A, the Food and Beverage Manager commented that fewer customers came in during the day than had been forecasted. However, the kitchen staff did not appear to have adapted forecasting as a result of fewer customers, which resulted in a high level of serving waste at the end of the day. The obvious reason for this is that one of the main objectives of the QSR chain in general is to “serve the expected number of visitors quickly” (Internal Food and Beverage Manual, 2012; p26). As such, ensuring enough food is available to serve the predicted customers quickly is paramount to restaurant operations. Adapting the forecasting would require a definite perception that the number of customers would stay lower than expected throughout the day. The kitchen staff likely did not want to take this risk. Further, the Food and Beverage Manager explained that forecasting in the staff restaurant is particularly difficult because the number of people who choose to eat in the staff restaurant changes day by day (Food and Beverage Manager, June 2013). Also, the head office regularly has visitors in (for training or national meetings) who are allowed to eat in the staff restaurant. The restaurant staff are generally advised of visitors on an ad hoc basis, however, the visitors may decide not to eat in the staff restaurant and instead leave the premises for lunch or eat in the customer restaurant. This results in the restaurant often preparing and cooking much more food than needed.

In Europe B, on the day of the waste audit, the staff restaurant held its weekly “vegetarian food” day, which may have impacted on the results. Every Monday, the staff restaurant only serves vegetarian food, which means a larger amount of on-site preparation and unavoidable food waste, such as vegetable and fruit peelings, than on a normal “meat” day. The Kitchen Manager commented that there is difficulty in forecasting in the staff restaurant but particularly so on “vegetarian food” days because you never know how many staff will be interested. Sometimes staff may realise it's vegetarian day so instead choose to buy food in the main restaurant. This results in a large amount of serving waste, as was evident on the day of the waste audit where 41 per cent of all food waste in the staff restaurant was in the serving line.

Europe B also has a strong focus on identifying synergies between the customer and staff restaurant where food can be reused without being wasted, so long as reuse aligns with food health and safety guidelines. This focus is primarily driven by the two Chilean chefs in the restaurant, who commented that they feel uncomfortable throwing food out at the end of the day when it could be reused in other recipes (such as Broccoli soup) or shared between the two restaurants the following day. This approach is evident through the large portion of storage waste in the customer kitchen, whereby food from the previous day was saved for reuse the following day, but unfortunately reduced in quality overnight so had to be discarded. Europe A, on the other hand, appears to have a much more strict approach when it comes to food waste in the serving line, resulting in all serving food waste being disposed of at the end of each day. The

difference could be either related to a difference in local legislation, whereby local legislation in Europe B could be less strict than Europe A when it comes to reusing serving food waste; Europe A is strictly following the Company Hygiene Plan, while Europe B only follows legislation; or that Europe B is more creative when it comes to reusing food waste legally than Europe A. Europe B is more creative when it comes to food reuse and redistribution between the restaurants than Europe A, which has likely resulted in less serving food waste in Europe B, particularly in the customer restaurant. The Chinese restaurants, like Europe B, also said that they have a strong focus on finding ways to reuse leftover food in other recipes and find synergies between the customer and staff restaurants to minimize avoidable food waste both in storage and the serving line. One restaurant worker commented that they are well aware that food waste is money, so any food that can be reused in the kitchen will be a financial benefit to them (Food and Beverage Manager, China B, June 2013).

As previously mentioned, all four restaurants have a company-wide system for recording food waste that occurs in the kitchen. When food is wasted in the kitchen, and this food waste is avoidable (i.e. excluding preparation food waste), the food wastage is supposed to be recorded in the system by cost. In Europe A, cost is also recorded as a proportion of turnover. However, it was unclear whether all restaurants strictly followed the recording procedures. We were advised that Europe A and B follow the procedures and, based on waste reports, it was likely they did for all food waste. However, the waste reports observed in China appeared to be smaller than in Europe, yet the Chinese restaurants were producing much more food waste in the kitchen. This could suggest the China restaurants do not keep a full record of all food wasted in the kitchen.

Both Chinese restaurants appeared to be producing a large amount of food waste in the kitchen, but around 90 per cent of this was considered unavoidable. The unavoidable food waste likely accounts for food waste produced in preparation. Asian cooking, by its very nature, requires a larger amount of preparation and thus more preparation food waste than western cooking, which could account for the high proportion of unavoidable food waste in the kitchen in both restaurants. Both European restaurants produced an extremely low proportion of preparation food waste, with all preparation food waste being classified as “unavoidable”, such as herb stalks. This is due to the fact that around 90 per cent of food preparation occurs off-site, meaning all preparation food waste likely occurs off-site as well.

### **3.5.3 Post-consumption**

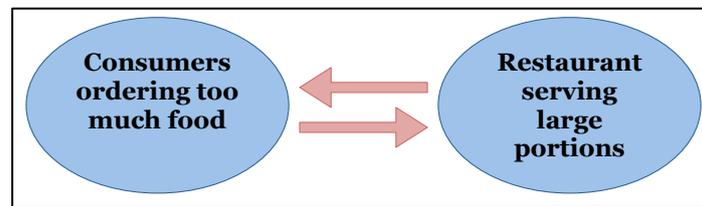
The Chinese restaurants had the biggest problem with post-consumption food waste, which accounted for an estimated 90 per cent of all food waste produced. Through onsite observations, it was immediately obvious that the local Chinese meals were much larger than the western standardized menu items, and that people were ordering a lot more food than in the European restaurants. The company-wide estimate of 2.2 customers per customer ticket may not have applied in China, with customers observed to be ordering often 2 hot main dishes per person, or three hot mains between two people. Customers were also observed to be leaving behind a large amount of food on their plates – often around 30 per cent. Customers were leaving behind all different types of food, but there was clearly a high incidence of rice and western-style pasta dishes being left behind on plates.

The reasons for the high level of post-consumption food waste in China were identified as twofold, and appeared to be both external and internal. First, restaurant staff advised that the Chinese have a “more is more” type culture. As was also identified in the literature, Chinese people prefer to order too much food and leave food behind on their plates than to not order enough food. Leaving food behind on your plate is considered a sign of affluence. Visually, this appeared to be more prevalent in China A than China B likely because China A is located in an urban (and therefore more affluent) area than semi-rural China B. We were also advised that

Chinese people culturally like to order lots of different types of foods. When faced with a western way of eating (i.e. single portions but larger portion sizes) they don't adapt their culture of wanting to try lots of different things. As such, they buy a few different main-sized meals just so they can have a variation, even though they don't intend on eating all the food.

Second, to satisfy the Chinese culture of wanting to leave food behind, the portion sizes offered in China were notably larger than in Europe. For example, the average hot dish in Europe is 320 g (Company Recipe Cards, June 2013), whereas the standard localized Chinese dish of beef and vegetables served in the restaurant is 489 g (recipe provided by Kitchen Manager, June 2013) – 169 g more than in Europe. A large proportion of this – 160 g – is made up of rice. Also, portion sizes weren't often checked for accuracy given the high volume of people served each day – the focus was on being able to serve people on time as opposed to checking portion sizes. The restaurant staff also advised that tailoring the meals to the Chinese way of eating (i.e. many smaller meal options) was not possible given the high volume of customers in the restaurant each day. Being able to serve the customers quickly was considered paramount.

Figure 14 Causes of pre-consumption food waste in Chinese restaurants



China B was trying to make some real progress towards educating its staff on food waste and reducing post-consumption food waste produced in the staff restaurant. China B had a waste sorting system for staff to use after their meal. Staff were requested to sort waste into residual, liquid and solid food waste components. The liquid food waste was fed directly into the wastewater system, but the solid food waste was placed in a bin above a set of scales. At the end of each day, the total amount of food waste was recorded and communicated to staff the following day. In the first few weeks that the system was implemented, staff were also provided with an incentive for eating all their food – a small gift from the department store. China B has seen a slight decrease in food waste in the staff kitchen as a result of this measuring and reporting system (Sustainability Specialist; Food and Beverage Manager, June 2013). However, China B has only looked at actual waste amounts produced, and this has not been compared to items sold or customers served in the staff restaurant, making it hard to accurately track progress.

Picture 7 – Food waste sorting system in China B staff restaurant



Europe B also had a higher proportion of post-consumer food waste than pre-consumer food waste, with around 65 per cent of all food waste being post-consumption. The highest proportion of post-consumption waste was in the customer restaurant, where around 80 per cent of the waste was avoidable. Food that was being thrown away largely consisted of main meal items and sides, such as Schnitzel and potatoes. Through observations and questioning some customers, it was identified that large portion sizes was definitely a major factor contributing towards customer plate waste, particularly when it comes to the size of sides. The large proportion of plate waste could also be a sign that customers are less conscious of food waste, and that are more likely to order and waste more food. Customer plate waste in the staff restaurant was also a major factor, however, 80 per cent of this was estimated to be unavoidable. Again, this could relate to the fact that it was “vegetarian food” day in the staff restaurant, which substantially increased the amount of fruit served in the restaurant, in turn increasing the amount of peeling waste.

Europe A did not have such a big problem with consumer plate waste, which only accounted for 30 per cent of all waste. Europe A appeared to be strictly following the standard portion sizes with the use of ergonomic serving instruments. The kitchen manager also explained that every few weeks or so he stands in the dishwashing room by the conveyor belt to inspect the type and amount of food that is left on customer plates, and adjusts the menu accordingly (Kitchen Manager, June 2013). Even following these measures, there was still a certain amount of plate waste produced. One reason for plate waste could be due to the typically cheap prices of menu items, which is standard for QSRs in general. Europe A, for example, offers a €1 breakfast option. During the breakfast rush hour, a lot of plate waste came from this menu item. Other reasons could be portion sizing, particularly the size of side meals, such as fries and potatoes.

## 3.6 Costs of food waste

### 3.6.1 Overview

As explained in the methodology, costing for Europe B was unable to be obtained. As such, the following section provides the estimated costs for Europe A and both of the Chinese restaurants. The calculations for the estimated total cost of food waste are made up of the estimated cost of purchasing food that’s wasted, the estimated cost of processing, preparing and cooking food that’s wasted, and the estimated cost of food waste disposal. These calculations are further explained in the Methodology and the Literature Analysis chapters of this report.

### 3.6.2 Estimated costs of food purchased and wasted

In each of the four stores, pre-consumption food waste (by cost) is recorded through the daily waste report. In Europe A, the cost of waste is also recorded as a proportion of monthly turnover. From January to May 2013, in the customer restaurant the average amount of pre-consumption food waste produced as proportion of turnover was 1.18 per cent. In the staff restaurant, the average amount was substantially higher at 19.81 per cent (spread sheet provided by Kitchen Manager, June 2013). Using these averages, Table 8 shows the cost of turnover and the estimated daily costs of pre-consumption food waste in the customer and staff kitchens. In both China restaurants, the total cost of waste produced in customer and staff restaurants as recorded in the Waste Item Contribution Report 2011/12 was around 0.6 per cent of turnover. Based on these proportions, Table 8 shows the average daily turnover and estimated waste costs for both China restaurants.

Table 8 – Total daily turnover and estimated daily cost of pre-consumption food waste from the case study restaurants

	Europe A			China A	China B
	Cust	Staff	Total		
<b>Turnover</b>	€11,700	€900	€13,000	€1,200	€600
<b>Estimated cost of food purchased and wasted</b>	€138	€170	€308	€7	€4

**Notes:**

Turnover rounded to the nearest €100.

Costs rounded to the nearest Euro.

Europe

- Turnover sourced from Hourly Sales Report for 17/06/2013 provided by Food and Beverage Managers, June and July 2013.
- Europe A waste sourced from monthly waste costs spreadsheet provided by Kitchen Managers, June and July 2013.
- Europe B waste cost proportion sourced from Waste Item Report 2011/12.

China

- Turnover sourced from Detailed Item Contribution Report 2011/12 for China A and B and averaged to daily turnover.
- Waste cost proportion sourced from Waste Item Report 2011/12.

### 3.6.3 Estimated costs of food waste disposal

In Europe A, the restaurant spends on average €0.2 per kg of food waste collected by the municipality (waste figures provided by Food and Beverage Manager, June 2013). Without pre-treatment, the costs of food waste disposal on the day in question for 156.7 kg of food waste would have therefore been around €33. With pre-treatment, the weight of the food waste would have reduced to around 100 kg. As such, the total cost for disposal of food waste produced on the day of testing with pre-treatment would be around €21. The QSR estimates the dewaterer operating costs for electricity and wastewater are €356 per year, or around €1 per day (documentation provided by Food and Beverage Specialist, July 2013). That means the total costs of food waste disposal on the waste audit day with pre-treatment would have been an estimated €22 – a savings of around €11.

In China, both stores pay a yearly set amount of food waste disposal, as opposed to a weight amount. In China A, the yearly cost in 2011/12 was around €810 and in China B the yearly cost was €660 (spread sheets provided by Food and Beverage Managers, June 2013). As such, the average daily cost for food waste disposal in China A and B is around €2.2 and €1.8 respectively.

Table 9 – Estimated daily waste disposal costs for Europe A and China stores

Europe A	China A	China B
€22.0	€2.2	€1.8

### 3.6.4 Estimated costs of processing, preparing and cooking

The estimated costs of processing, preparing and serving food are based on three parameters: energy, water and staff costs attributable to wasted food. As suggested by the Irish EPA, these costs could be based on the proportion of food that is wasted compared to food that is consumed (Environmental Protection Agency Ireland, 2010). Based on assumptions and

calculations further explained in the Appendix, it was estimated that (by weight) around 8 per cent of food intended for human consumption was wasted daily in Europe A, 35 per cent was wasted in China A and 18 per cent was wasted in China B.

In each restaurant system, there are no separate meters to determine the actual energy and water consumption of the customer and staff kitchens and restaurants. Rather, energy and water is monitored and paid for on a storewide basis with a certain percentage allocated to customer and staff restaurant operations. Based on these allocations, Table 8 provides the estimated daily cost and usage for energy and water attributable to food waste for each of the studied restaurants. China A uses natural gas and electricity so the usage and cost includes both, unlike Europe A and China B, which only use electricity.

Actual figures were not obtained from the Europe or China stores on the total number of staff hours per day or the average salary for staff. As such, estimations have had to be made as to the total cost of staffing per day. For Europe A, the estimations are based on the assumption that the average hourly wage for a waiter or server in the Netherlands is around €10 (Payscale website, 2013); and the assumption that 15 staff each worked 11 hour shifts on the day of the waste audit (being a total of 165 hours). In China, the estimations are based on an assumption that staff in the restaurant earn around €1.5 an hour. This assumption is based on the fact that the average wage for restaurant workers is around 2536 RMB per month or 10.6 RMB (€1.3) an hour for five 8-hour days a week (China Economic Review, 2012), and an assumption that the Shanghai QSRs studied pay staff slightly above average. The estimations are also based on an assumption that in China A, 13 people work for 11 hours (being a total of 143 hours) and in China B, 8 people work for 11 hours (being a total of 88 hours) on the average working day. Based on these estimations, Table 8 provides the total estimated cost of staffing attributable to food waste.

Table 10 – Estimated daily costs of electricity, water and staffing attributable to food waste

	Europe A	China A		China B
Energy		<i>Electricity -</i>	<i>Gas -</i>	
- Use	200 kWh	1100 kWh	30 m <sup>3</sup>	500 kWh
- Cost	€12	€110	€16	€50
Water				
- Use	5 m <sup>3</sup>		60 m <sup>3</sup>	7 m <sup>3</sup>
- Cost	€4		€30	€3
Staff cost	€132		€75	€24
<b>Total estimated cost</b>	<b>€148</b>		<b>€231</b>	<b>€77</b>

**Notes:**

Figures have been rounded from original calculations.

Costs attributable to food waste are –

8 % of total costs in Europe A

35 % of total costs in China A

18 % of total costs in China B

The restaurants analysed were unable to advise on or estimate the proportion of electricity or water directly attributable to preparing, processing and cooking food (i.e. how much electricity is

used for lighting versus cooking). As such, it was not possible to make these further estimations, so only the estimated figures calculated in Table 10 could be used.

### 3.6.5 Total cost of avoidable and unavoidable food waste

The total estimated costs of all food waste and the estimated costs of avoidable food waste for all restaurants are provided in Table 3.8. The cost for avoidable food waste is based on the MFA finding that in Europe A, 91 per cent of all waste produced is avoidable, and in China A and B, 73 per cent is avoidable.

*Table 11 – Total estimated daily costs of food waste and total estimated daily and annual costs of avoidable food waste (and as a proportion of turnover) in the case study restaurants*

	Europe A	China A	China B
Costs of food purchased and wasted	€308	€7	€4
Costs of food waste disposal	€22	€2.2	€1.8
Costs of processing, preparing and cooking	€148	€231	€77
Total estimated costs	<b>€478.0</b>	<b>€240.2</b>	<b>€82.8</b>
- <b>Avoidable</b>	<b>~ €430</b>	<b>€175</b>	<b>€60</b>
- <b>Avoidable / year</b>	<b>~ €160,000</b>	<b>~ €64,000</b>	<b>~ €22,000</b>
Estimated proportion of daily turnover (avoidable)	3 %	15 %	10 %

## 4 Comparative Analysis

### 4.1 Comparison between the case studies

The European case studies were clearly the “higher performing” restaurants when it comes to food waste. The European restaurants produced much less food waste than the Chinese restaurants in total and on a per customer ticket and per employee basis. Europe A was the highest performing restaurant when it comes to total amount of waste produced per customer and per employee, while Europe B produced the least amount of food waste in total. China A was the lowest performing restaurant and produced the highest amount of waste in total and per customer ticket and employee. The Sankey diagrams show that the Chinese restaurants were also producing much more waste than the European restaurants when compared to the estimated amount of food actually intended for human consumption, with China A wasting an estimated 35 per cent of food by weight, and Europe A only wasting an estimated 8 per cent.

The findings show that the case studies were quite different and faced extremely different challenges. However, there is clear potential for the case study restaurants to learn from one-another’s experiences in order to minimise food waste. The information obtained through the case studies suggest that the two major factors that contribute towards a difference in the amount and source-profiles of waste generated in each of the restaurants relate to (1) the large amount of post-consumption plate waste generated in the Chinese restaurants, and (2) the way in which serving and storage food waste is apparently dealt with in Europe B and both Chinese restaurants through finding creative ways to reuse it in other recipes.

The MFA identified that the main difference between the Chinese and European restaurants primarily related to the amount of post consumption food waste in China. In both Chinese restaurants, an estimated 90 per cent of all food waste was post-consumption food waste. This means that of the 0.4 g of food waste produced per customer in China A, around 0.36 g of food was actually left behind on customer plates at the end of the meal. Assuming each customer ticket represents around 1 kg of food, that’s more than 30 per cent of food wasted on customer plates per customer ticket. In Europe A, however, only 28 per cent of food waste produced was post-consumption food waste. This means that of the 0.07 g wasted per person, only 0.02 g of food was customer plate waste, which is extremely minimal in comparison. Europe B produced a much higher proportion of post-consumption food waste than Europe A (around 64 per cent – or 0.05 g of 0.08 g wasted per customer ticket). This was, however, substantially less than the Chinese restaurants.

Post-consumption food waste in China was driven primarily by the Chinese eating culture – including both the desire for Chinese people to order more food than required and the desire for the restaurant to serve excessive amounts of food to satisfy this need. While the European customers may have also been wasteful to a certain degree, this was nowhere near the wasteful culture of the Chinese. This is an extremely interesting finding because it highlights the difficulties in establishing global food waste prevention and provides an example of how the customer culture can substantially drive food waste production in a QSR.

The difference in waste quantity and source-profiles also related to the different in proportions and amounts of pre-consumption food waste produced across the restaurants. Pre-consumption food waste was much more of an issue (proportionally) in Europe A given over 70 per cent of food waste was produced in the kitchen – largely in the serving line. Europe B only produced around 40 per cent of food waste in the kitchen and largely in the serving line, although a large portion of this was unavoidable. Proportionally, pre-consumption food waste was much less of an issue in

the Chinese restaurants, although they still produced a similar amount to Europe A (but, like Europe B, a higher estimated proportion of unavoidable food waste).

The main reason for this difference appeared to be Europe A's attitude towards serving waste compared to the other restaurants. Europe A had a very strict approach to hot and cold serving food waste, where all food was thrown out at the end of the day. It is likely this was both for health and safety reasons but also considered a convenience factor. Europe B, on the other hand, appeared to be more willing to find ways to reuse this food the following day in different recipes, and particularly identify synergies between the customer and staff restaurant for sharing food. This contributed to the reduction of serving waste compared to Europe A, but the increase in storage waste. Similarly, the Chinese restaurant also appeared to have a relaxed and innovative approach to reusing serving food waste. It is important to point out that the local food health and safety regulations in China and Europe B may be less strict than the Company Hygiene Plan and the Dutch food health and safety regulations (than Europe A follows), meaning the other restaurants may have more room for creativity. Additionally, given the Chinese restaurants produce such a low amount of food waste in the kitchen as a proportion of turnover, this could indicate that the Chinese restaurants do not accurately record all food waste in the kitchen, or provided inaccurate estimates of pre-consumption food waste.

With regards to financial incentives, the cost component of this study found that Europe A does benefit financially from preventing avoidable food waste at source, when compared to both the Chinese restaurants who produce more food waste. Europe A faces substantially lower costs for avoidable food waste as a proportion of turnover (around 7-12 per cent less) than both of the Chinese restaurants, when calculating the full costs of food waste. One of the major factors contributing to the larger proportion of costs for the Chinese restaurants is the estimated costs spent on energy, water and staffing to process, prepare and cooking food that's wasted – the costs in China would have been minimal had these hidden costs been excluded from the calculation. However, the findings show that if the Chinese restaurants could implement measures to reduce food waste, they have the potential to save a substantial amount of money annually.

All three restaurants were estimated to be wasting a large amount of electricity and water on processing, preparing and cooking food that's wasted. However, the Chinese restaurants were estimated to be particularly wasteful with regards to electricity– from 500 kWh – 1100 kWh of electricity each day (excluding gas wastage in China A). China A was also wasteful of water, wasting an estimated 60 m<sup>3</sup> per day. While these estimates are not perfect and, as discussed in the Literature Analysis, the methodology has some flaws, this study still shows the possible extent of resource wastage as a result of producing food waste.

## 4.2 Comparison with the literature

### 4.2.1 Overview

The case studies provided mixed results when compared to the literature. The following section provides a brief comparison between the European and the Chinese case studies and the findings of the literature analysis with regards to the quantity, source, costs and causes of food waste in QSRs.

Table 12 – Quantity, source and estimated cost of food waste identified in case studies and in the literature

Comparison Parameters	Case Study findings				Literature findings				
	Europe A	Europe B	China A	China B	WRAP 2011	SRA 2010	SMED 2011	Lean Path	EPA Ireland 2013
<b>Waste per day (kg):</b>									
-Per customer	157	101.5	1500	400	156	59.8	-	-	-
-Per employee	0.07	0.08	0.4	0.2	-	0.48	-	-	-
	1.7	1.3	28.8	13.8	2.2	-	2.9		-
<b>Source (%):</b>									
-Spoilage	69.3	23.6	10	10	-	5	-	-	-
-Prep	2.4	12.9			-	65	-	-	-
-Customer	28.4	63.5	90	90	-	30	-	-	-
<b>Costs:</b>									
-Proportion of turnover	3 %	-	15 %	10 %	-	2-3 %*	-	4-10 %*	-
-Per kg of food waste	€3	-	€0.2	€0.2	€2.1**	-	-	-	€2**

**Notes:**

\* Figures estimated are only for costs of food purchased and wasted

\*\* Figures estimated are only for costs of food purchased and wasted and costs of food waste disposal

### 4.2.2 European case studies

Europe A produces the average amount of food waste found in WRAP (2011) for a QSR with 50-99 employees (being 156 kg a day). However, it produces 0.5 kg less waste per employee, which suggests that, given Europe A is on the higher end of the WRAP size scale with 90 employees, it is performing better than average when it comes to the amount of waste it produces each day. Europe B, when compared to the WRAP (2011) study, produces 55 kg less food waste in total and 1.1 kg less per employee each day than the average QSR. This suggests that Europe B is performing better than the average QSR when it comes to food waste prevention. Europe A and B are also producing much less food waste per customer ticket than the average restaurant in the SRA (2010) study. In Europe A and B, the amount of waste produced per customer ticket was only 0.07 kg and 0.08 kg respectively, which is 0.4 kg less than the average restaurant in the SRA (2010) study. It could be that restaurants in general produce more food waste than QSRs

due to the higher degree of onsite preparation, however, the WRAP (2011) study was somewhat inconclusive of this given the likelihood of outliers due to a small sample size.

Further, in normal “fast casual restaurants”, such as the case study restaurants, we would almost expect a higher amount of food waste than traditional QSRs due to the higher eat-in ratios. In fast casual restaurants food is more often consumed in-store meaning it is also disposed of by customers in-store, whereas in traditional QSRs there is a much higher degree of take-out, meaning food waste also leaves the store with the consumer on purchase. This would suggest that not only are Europe A and B performing better than traditional QSRs, they are also performing better than other “fast casual restaurants”.

There are mixed results for the European case studies when it comes to avoidable food waste. The WRAP (2011) study found that QSRs produce around 70 per cent avoidable food waste, whereas Europe A produces 91 per cent and Europe B produces 75 per cent avoidable food waste. The reason that Europe B more closely aligns with traditional QSRs could be due to its more flexible approach when it comes to reusing food that would otherwise be wasted – unlike Europe A which appeared to have a much more strict approach. It could be that Europe A is much more strict than traditional QSRs when it comes to reusing food waste or following food health and safety procedures for kitchen food waste. It could also be that traditional QSRs have forecasting that is even more accurate than Europe A, particularly when it comes to serving hot foods that have strict holding times. It could also be that other QSRs have a higher degree of on-site preparation food waste than the case study QSRs, resulting in a higher proportion of unavoidable food waste.

The source-profiles of food waste in the European restaurants are much different to the average restaurant identified in the SRA (2010) study. The difference is largely due to the high proportion of spoilage waste in both restaurants compared to the SRA restaurants. The SRA restaurants only produced on average 5 per cent spoilage food waste, whereas Europe A and B produced 69.3 per cent and 23.6 per cent respectively. This difference is likely due to the nature of QSRs in general when compared to normal restaurants. QSRs need to be able to produce food to the customer immediately, whereas in normal restaurants food can be made to order. This means that normal restaurants do not have the problem of having to throw out cooked food that hasn't been sold at the end of the day due to food health and safety regulations. Rather, in normal restaurants, food would generally only be cooked once the customer has ordered it (with some exceptions – such as restaurant cabinet food).

The large proportion of food waste produced in spoilage in the case studies is offset by the low proportion produced in preparation. The SRA (2010) study found that preparation food waste is a major hot spot in restaurants when it comes to food waste, whereas preparation food waste barely featured in the European case studies. Again, this is due to the general nature of QSRs compared to normal restaurants, whereby a high degree of food preparation occurs offsite, meaning that food waste is not produced within the confines of the restaurant but rather with the manufacturers or retailers. It is also important to point out that the SRA (2010) study did not distinguish between “avoidable” and “unavoidable” food waste. It could be that a high amount of preparation food waste produced in the SRA restaurants was unavoidable.

The European case studies did not identify any particular causes of food waste that had not been outlined in the literature review. However, they did confirm that preparation is not a major cause of food waste in QSRs generally when compared to normal restaurants. They also confirmed that QSRs have a high reliance on forecasting and planning to minimize losses, particularly when it comes to serving food waste. The case studies further highlighted the restrictions placed on QSRs with regards to food health and safety regulations, which had not been largely emphasized

in the literature (perhaps because the restrictions are easier to deal with in normal restaurants). Europe A and Europe B had slightly different approaches and perhaps interpretations when it comes to food safety, and Europe B appeared to be reusing a lot more food from the previous day in other recipes than Europe A, who was routinely throwing out all cooked food at the end of the day.

The total cost of food waste to Europe A (including the costs of preparing, processing and cooking food that is wasted) appears to be below average when compared to literature. Europe A spends an estimated 3 per cent of turnover for food waste, whereas studies have found that the cost of food wasted in the kitchen can alone amount to 2-10 per cent of turnover (SRA, 2010; LeanPath, undated). This suggests that Europe A's focus on food waste prevention for cost-saving purposes is beneficial when compared to other restaurants and is resulting in financial savings. Europe A does pay nearly €1 more per kg of food waste produced than identified by both WRAP (2011) and the Environmental Protection Agency Ireland (2013). However, the difference is accounted for in the fact that the studies did not specifically include the costs of preparing, processing and cooking food that's wasted.

### **4.2.3 Chinese case studies**

Both Chinese restaurants were producing much more food waste in total and per employee than the average QSR of the same size, when compared to the WRAP (2011) study. China A produces nearly 10 times the average amount of food waste, and China B produces nearly 3 times the average. This is similar when comparing the "per employee" amount. There are two main things to take into account, however, when comparing the China case studies with European studies. First, while the Chinese restaurants appear to be performing badly when compared to UK QSRs, they may be performing well when compared to other Chinese QSRs. Unfortunately no studies or statistics could be obtained to compare the Chinese case study with other Chinese QSRs. Second, the amount of food waste produced per employee is extremely high for both China A and B, which could suggest that the total number of employees provided by both stores was inaccurate. However, as already established, the Chinese restaurants do produce a much higher amount of waste than the European restaurants, which could also result in a much higher amount per employee.

The Chinese restaurants appear to be producing slightly more avoidable food waste than the average QSR. Again, there is difficulty in comparing the Chinese case studies with QSRs in the UK. In particular, the Chinese case studies have 50 per cent locally adapted Chinese food, which could result in a much higher amount of unavoidable preparation food waste than traditional QSRs – especially considering Asian cooking in general produces more preparation food waste, such as vegetable peelings, than western cooking. However, the high proportion of avoidable post-consumption food waste produced in both restaurants by the customers overshadows this.

The Chinese case studies also have substantially different food waste source-profiles than the restaurants in the SRA (2010) study, with the difference largely relating to the extremely high proportion of post-consumption food waste in China. Again, this is likely to do with the food waste problem in China in general as opposed to the specific QSRs studied. This finding aligns with the Chinese literature, which indicates that Chinese people in general dispose of an extremely high proportion (around 30 per cent) of their food in restaurants (Zhou, 2013; Chinese Agricultural University, 2013). If there was a study similar to the SRA (2010) study conducted in China, it may well have found similar source-profiles across all different types of restaurants and not just the QSRs studied.

The cost of food waste was also higher-than-average in the Chinese case studies when compared to the literature. Further, as previously explained, it is possible that the Chinese case studies do not

fully record the cost of food waste in the kitchen, which, if recorded properly, could substantially increase the cost of food waste. The cost of food waste per kg produced in the Chinese restaurants was much less than identified in WRAP (2011) and the Environmental Protection Agency Ireland (2013) guidelines, when converted to Euros. However, this could be due to that fact that food and food waste disposal is substantially less in China than in the EU.

## 5 Discussion

### 5.1 General applicability of the findings

The findings of this study are applicable in a number of ways. The study highlights the importance of restaurants and the food service industry generally in achieving food waste reduction targets. The impact of food service industries on food waste production globally is substantial and the food service industry has a central role to play in the future of food sustainability. Further, restaurants provide the medium between suppliers and consumers, so they are in an excellent position to engage with higher and lower stages of the food supply chain to reduce food waste. The literature review highlights the general difficulties associated with food waste prevention in restaurants, including having a universal definition of food waste; monitoring and measuring food waste; setting comparable benchmarks and targets; and identifying and communicating the full financial costs of food waste to restaurants. The literature review also highlights the conflict between need to reduce food waste but also wanting to increase sales to customers.

The case study highlights that even in chain QSRs that operate in a similar manner globally, the food waste problem can differ dramatically depending on the local conditions and the culture of the staff and customers. While all the case study restaurants operate within the same framework, the difference in the eating culture of Chinese people and the staff means that the causes of food waste were found to be completely different in the Chinese and European restaurants. The study also shows that two European restaurants in the same chain operating in similar culture conditions could also have different food waste problems as a result of how each restaurant deals with serving food waste at the end of the day. The study also demonstrates that a few high-level employees can drive pre-consumption food waste prevention as appeared to be the case in Europe B. This is an important finding for any QSR or restaurant chain that operates globally, in that there cannot necessarily be one “quick fix” to reduce or minimize food waste that will be applicable across all restaurants in the chain. While addressing post-consumption food waste in China (through for example reducing the amount of rice served with each meal) is likely to have a big impact on food waste prevention, measures in Europe A would be better targeted towards reducing serving food waste (through for example finding innovative and creative ways to reuse left-over serving food legally).

The study demonstrates that the source of food waste in QSRs specifically appears to be different to normal restaurants in that there is minimal food waste produced in food preparation, and the food waste that was produced in preparation was found to be largely unavoidable. Rather, the food waste problem in QSRs, or “fast casual restaurants” in particular, is more focused around serving food waste and customer plate waste, meaning any food waste prevention measures would be more effective and efficient if they target ways to reduce these types of waste. While preparation food waste is not a problem onsite in QSRs, it is however an issue when it comes to sustainable sourcing. Most of the food waste produced in preparation will occur off-site, meaning it is still the restaurant’s responsibility to ensure that suppliers are sustainable when it comes to preparation food waste. However, sourcing decisions are often based on price, and where food is prepared in an area where it is not so costly to waste food, the actual cost of food waste produced in preparation may not be accurately represented in the price of purchasing pre-prepared food.

The study also has some interesting findings when it comes to costs. In particular, it demonstrates that when looking only at the cost of food purchased and wasted, and the costs of food waste disposal, the perceived costs of food waste may not be high enough to provide an incentive for its prevention. This is particularly so in countries such as China where it is not

overly expensive to dispose of food waste. However, food waste becomes much more costly when we also consider the estimated energy, water and staffing costs of preparing and cooking food. In all three restaurants, these costs were high. In particular, the Chinese restaurants costs increased substantially as a result of including the “hidden” costs of energy, water and staffing attributable to food waste. As such, this study highlights the importance of including these costs because they can substantially increase the estimated costs of food waste for each restaurant. The study also highlights that food waste can be costly for restaurants if they do not get it under control. Even Europe A, which is relatively good at preventing food waste, spends an estimated €160,000 a year on avoidable food waste.

In considering the costs of energy and water spent on preparing, processing and cooking food that is wasted, this study also highlights the possible extent of resource wastage in restaurants as a result of food waste. The case study restaurants wasted between 200 – 1100 kwh a day of electricity, which adds up to around 70,000 – 400,000 kWh a year potentially wasted on preparing, processing and cooking food that is not ultimately consumed as intended. The environmental impact of this consumption was not further investigated in this study given electricity and water consumption may have a different environmental impact in each of the countries studied depending on, for example, whether electricity is from a renewable or not renewable source. In China, however, a country that has such a high reliance on burning coal for electricity, every kWh of electricity produced through burning coal can release around 1 kg of carbon dioxide (US EIA website, 2013). This could highlight the fact that from an environmental point of view it could be more important to save electricity in some countries than others.

## 5.2 Appropriateness of Research Methodologies

The research methodologies had some strengths and weaknesses, which could be improved in further studies. Focusing on restaurants within the same QSR chain was a good approach because it meant that the way in which the restaurants operated was generally the same. As such, food waste differences due to other factors, such as substantially different menus, different modes of operating, or different formats, could generally be eliminated. However, there were difficulties in comparing restaurants that were in completely different cultural settings. This meant that changes in food waste causes were essentially driven externally (when considering customer plate waste in China), and not always something the restaurants could easily adapt to. However, the European case studies showed that two restaurants in similar cultural settings could still face differences in the causes of food waste (external factors being relatively similar), so it may have been more interesting to compare “lower performing” European case studies, as opposed to Chinese case studies with European.

The MFA was a useful tool for pinpointing exactly where the food waste was being produced in each restaurant system. If only the total amount of waste produced was taken in to account (as in WRAP, 2011), it would have been difficult to understand the differences between the restaurants studied, other than the fact that the China restaurants were producing more waste than the European restaurants. It would have been more helpful if actual waste data could have been collected in China to ensure that the waste profiles estimated by employees and through observations were accurate. Further, the information across all restaurant systems would have been much more reliable if it could have been collected over a longer period of time, other than just one or two days. This was not logistically possible within the time frame. However, discussing waste volumes and sources with staff members in all restaurants proved helpful in understanding the standard quantity and source of food waste produced per day.

There were also strengths and weaknesses in the methodology used to calculate the costs of food waste. The methodology used for calculating the costs of purchasing food that is wasted had some weaknesses in that it relied entirely on restaurants keeping an accurate record of food

wasted in the kitchen. This is not always the case. In particular, China had much lower costs (relatively) when it came to avoidable food waste in the kitchen than Europe A, which could have indicated that they weren't recording all their costs in the Waste Report. The other option would have been to estimate a standard percentage, as suggested by the SRA as 2-3 per cent of turnover. However, given the SRA study was UK-based and these were Chinese restaurants, this estimation may have been just as unreliable.

The methodology used for developing the Sankey diagrams also had some obvious weaknesses. For calculating the proportion of food wasted versus food intended for human consumption and so on, only rough calculations could be made and the number of unknowns (specially the total weight of food intended for human consumption) were significant. However, the methodology still provided a helpful (yet rough) estimation of the proportion of food wasted in the restaurant.

There were also some weaknesses in carrying these proportions through to estimate the total cost of processing, preparing and cooking food that is wasted. The methodology was based on an assumption that weight dictates the amount of energy, water and staff time spending on preparing and cooking the food, when this is unlikely to be the case. Density, for example, may have provided a better measure. It also assumes that the total costs for energy, water and staffing are spent on preparing and cooking food, when costs could be attributed to other things such as lighting, staff toilets and showers, or staff time spent on administration; and it doesn't provide for the fact that some types of foods require more processing and cooking than others, and food is wasted in various stages throughout the restaurant material flow cycle. Given the difficulties in estimating the costs of preparing and cooking food, this methodology still helps to provide a ballpark figure, which could be reduced accordingly based on the individual situation of restaurants. A future adaptation to the methodology could be to ascertain or estimate exactly what proportion of energy and water is attributable to preparing, processing and cooking (and storing) food that's ultimately wasted (i.e. some how eliminate costs spent on air-conditioning, for example). It could also involve a much thorough understanding of the exact type of food that's wasted and the point in the material flow that is wasted (i.e. in storage, or after serving for example), in order to fully calculate the actual costs. However, as it stands, the methodology is still a useful tool for providing a loose estimation of the costs.

### 5.3 Suggestions for further research

This study highlights the need for further research regarding food waste prevention in restaurants and QSRs. In particular, there is a real need for comparative studies between different restaurants and studies that present "best case" restaurants in terms of the amount of food they produce and the amount they spend on waste. These studies would be helpful in highlighting and addressing the issue of food waste in restaurants and setting some benchmarks for how restaurants should perform when it comes to the amount of food waste they produce. For such studies to have general applicability, there is a need for similar points of comparability across the studies, as suggested by Norden (Nordic Council of Ministers, 2012). The basis for comparability could be the amount of food waste produced per customer served or per staff member, and costs should be compared to turnover. This means that a range of different studies and case studies could be compared against one another. These studies would also be helpful because they show restaurants how to quantify and calculate the costs of food waste.

There is also a real need for studies similar to the WRAP (2011) and SRA (2010) studies across different countries and on a much larger scale. The literature review highlighted the limitations in the available data and particularly when comparing the literature to the case studies. Further studies of this nature would be extremely helpful because they would provide individual restaurants and QSRs with a clear basis for comparison against average performing restaurants. Where they identify that they are performing lower than average, and spending more on food

waste than average, this might provide individual restaurants with the required motivation to prevent food waste from source.

Further, there is a real need for more studies on how the costs of processing, preparing and cooking food that is wasted should be calculated. Minimal studies on this topic were identified, which explains why a somewhat weak methodology was used to estimate these costs. It is unclear what such studies could look like, but could involve actual field testing on the “use-costs” associated with cooking certain types of common foods in generic kitchens – both QSR and other.

Other wider studies that could be undertaken following this study include understanding from a policy point of view what the impact is of food health and safety regulations on the production of food waste. It would also be interesting to better understand how restaurants interpret food health and safety regulations when throwing out food waste and whether there is a miscommunication in the interpretation that results in more food waste (i.e. do restaurants throw out food in the belief that it is a legal requirement when perhaps it is not). Lastly, it would also be interesting to understand the impacts of different food types on the environment throughout their life cycle (for example meat) and whether more emphasis should be put on preventing certain types of food waste over others from a life cycle perspective.

## 6 Conclusions

This study highlights the importance of restaurants and the food service industry in reaching food waste prevention targets. It also highlights the knowledge gap with regards to food waste prevention in restaurants and that addressing food waste in the consumptive stages of the food supply chain has primarily focussed on retail and household consumption, as opposed to the food service industry. Further, food waste in the food service industry has generally been addressed from a management perspective as opposed to food waste prevention. Prevention is, however, important for meeting food waste reduction targets and improving resource efficiency.

To fill part of this knowledge gap, this study sought to take a top-down approach to food waste by exploring and understanding the quantity, source and cause of food waste in QSRs and how food waste prevention measures can benefit QSRs financially, in order to help QSRs and restaurants generally reduce onsite food waste. This study highlights the difficulties involved in food waste prevention for individual QSRs and demonstrated that there may not be one “quick fix” for reducing food waste in a QSR restaurant chain. This is because different QSRs within the same chain can face completely different challenges when it comes to the quantity, source and cause of food waste. This study demonstrates that food waste production can be largely driven by the culture of the particular customers and the staff in responding to that culture (as was the case in China); and that food waste minimization can be driven internally in the kitchen by key kitchen staff who are innovative and creative in finding ways to reuse what would otherwise be considered pre-consumption food waste (as was the case in Europe B and potentially China).

This study also highlights the importance of addressing food waste in QSRs in storage and serving, and post-consumption food waste generally, as opposed to preparation food waste, which was found to be minimal when compared to ordinary restaurants. To this end, accurate forecasting and planning in QSRs is particularly important to reduce serving food waste, including adapting to forecasting throughout the day. Similarly, serving food waste can be reduced through finding innovative and creative ways to reuse it in other recipes or redistribute to the staff restaurant. This study also highlights the importance of portion control and sizing to ensure the customer receives correct portion sizing to avoid post-consumption food waste. The Europe A case study demonstrated that food waste could be minimised where portion control is strictly applied and followed. The case studies in China demonstrated that having portion sizes that are too big – even if that is what is culturally desired – could substantially increase the amount of food waste produced on site. Checking the amount and type of food waste produced on customer plates is also an important measure to ensure portion sizes are adequate, and customers are not routinely wasting a certain type of food.

This study also highlights the importance of full costing food waste in restaurants. It demonstrates that the estimated costs of food waste within the same restaurant chain can vary from around 3-15 per cent of turnover depending on the specific circumstances of restaurants and the local conditions. It also shows that the perceived costs of purchasing food that is wasted and disposing of food waste may not be high enough to provide an incentive for food waste production. However, the estimated costs of food waste increase drastically when you take into account the costs of preparing and cooking food that’s wasted. When full costing food waste, even a restaurant that is considered “high performing” when it comes to food waste can still pay nearly €200,000 per year on food waste, when the costs of preparing and cooking food that’s wasted are factored in.

Preventing food waste in restaurants and QSRs could have a significant impact on preventing food waste globally. The study shows that the potential for food waste reduction and financial savings is substantial, even in restaurants that are considered “higher performing” when it comes

to food waste. Simple food waste prevention measures, such as slightly decreasing the portion size (particularly the size of rice) or offering a range of portion sizes, could have a substantial impact on food waste production and save restaurants a significant amount of money. Further, finding innovative and creative ways to legally reuse serving food waste in QSRs, and ensuring forecasting and planning systems are accurate, could also help restaurants substantially decrease the amount of food that is ultimately wasted at the end of the day. Reducing food waste would naturally have the added flow-on effect of reducing energy and water consumption associated with processing, preparing and cooking food that's wasted. In the worstcase scenario, it was estimated that reducing avoidable food waste could potentially save around 30 per cent of these costs.

Following this study, suggestions for further research include presenting more best case and worst case studies as bases for comparison for other restaurants, and providing more large scale (national and international) studies on the quantity and source of food waste in restaurants. Such studies, however, need to use clearly comparable measures – such as food waste produced per customer served and/or per employee. Costs should also be compared to turnover. Other further research could involve looking in to the impact of food health and safety regulations on food waste production, and whether more emphasis should be placed on preventing certain types of food being wasted to reduce environmental impact from a life cycle perspective.

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## **Primary interviews and documentation**

### **Europe A, 16-19 June 2013**

Interviews:

- In-store:
  - Food and Beverage Manager
  - Kitchen Manager
  - Sustainability Specialist
  - Kitchen staff
- Head Office:
  - Food and Beverage Specialist
  - Food and Beverage Matrix Manager

Documentation:

- Monthly waste, energy and water statistics for 2012/13 – cost and usage
- Hourly sales report 17 June 2013
- Spreadsheet with requested information on floor size, number of employees, customer tickets, item sales.
- Monthly kitchen waste report, 2013
- Internal Food and Beverage Manual, 2012
- Information sheet on dewaterer including operational costs.
- Guide to minimizing food waste
- In-store communication guidelines; general company background information for employees.

### **Europe B, 21 June and 24 August 2013**

Interviews:

- Kitchen Manager
- Sustainability Specialist
- Kitchen staff

Documentation:

- Spreadsheet with requested information on customer tickets and item sales.
- Detailed Item Contribution Report, 2012/13
- Waste Report 2012/2013

### **China A, 5 June 2013**

Interviews:

- In-store:
  - Food and Beverage Manager
  - Maintenance Manager
  - Kitchen Manager

- Head Office:
  - Sustainability Specialist
  - Food and Beverage Manager for whole of China

Documentation:

- Monthly energy and water statistics for 2012/13 – cost and usage
- Spreadsheet with requested information on floor size, number of employees, customer tickets, item sales.
- Detailed Item Contribution Report, 2012/13
- Waste Report 2012/2013

## China B, 6 June 2013

Interviews:

- Acting General Manager / Food and Beverage Manager
- Maintenance Manager
- Kitchen Manager

Documentation:

- Monthly energy and water statistics for 2012/13 – cost and usage
- Spreadsheet with requested information on floor size, number of employees, customer tickets, item sales.
- Detailed Item Contribution Report, 2012/13
- Waste Report 2012/2013
- Powerpoint presentation on food waste reduction in staff restaurant

## Appendix

### Estimating the proportion of food wasted by weight

#### Overview

To estimate the total proportion of food that was wasted by weight in each store, the following calculation was constructed:

$$F = (C + P + K)$$

Where: F is the amount of food intended for human consumption; C is the amount of food actually consumed; P is the amount of food wasted on consumer plates; and K is the amount of food wasted in the kitchen. For each restaurant studied, we already know K and P. As such, estimations were made as to the value of C and therefore F. To figure out the value of C, we first need to estimate the total weight of food sold to customers (i.e. C + P). Once we know C, we can easily calculate F using the above equation.

#### Europe A

In Europe A, on the day of the waste audit, each customer in the customer restaurant purchased on average 5.4 items and each consumer in the staff restaurant purchased on average 3.4 items. Each customer ticket in the customer restaurants represents on average 2.2 people and each customer ticket in the staff restaurant represents 1 person (Food and Beverage Specialist, June 2013). Based on this, an assumption was made that each customer ticket in the customer restaurant includes on average 2 hot meals, 2 drinks and 1.4 cold meals, and each customer ticket in the staff restaurant includes on average 1 hot meal, 1 salad bar serving, 1 drink and 0.4 cold meals.

In the customer restaurant, the average weight of hot meals is 320 g and the average weight of cold meals is 160 g (Company Recipe Cards Europe A, obtained June 2013). We can assume the average weight of a drink is 50 g, and the average weight of a salad bar serving is also 50 g. If we exclude the weight of drinks (given drink waste is not included within the scope of this study), we can then estimate that the average weight of food served per customer ticket in the customer restaurant was around 0.9 kg and the average weight of food served per customer ticket in the staff restaurant was around 0.4 kg. On the day of the waste audit, 1668 customers were served in the customer restaurant and 596 customers were served in the staff restaurant. That means the estimated weight of food sold to customers is around 1,500 kg in the customer restaurant and 240 kg in the staff restaurant.

*Total estimated weight (kg) of food consumed by customers and staff (excluding drinks) on the day of the waste audit*

	Food sold to customers (P+C)	Food wasted by customers (P)	Food consumed (C)
<b>Customer restaurant</b>	1,500 kg	30 kg	1,470 kg
<b>Staff restaurant</b>	240 kg	13 kg	227 kg
<b>Total</b>	1,740 kg	43 kg	1,697 kg

*Total estimated weight (kg) of food consumed and food wasted on the day of the waste audit*

	Food consumed (C)	Food wasted		Total (F)
		Pre-consumption (K)	Post-consumption (P)	
<b>Customer restaurant</b>	1,470 kg	71 kg	30 kg	1,571 kg
<b>Staff restaurant</b>	227 kg	41 kg	14 kg	282 kg
<b>Total</b>	<b>1,697 kg</b>	<b>112 kg</b>	<b>44 kg</b>	<b>1,853 kg</b>

Based on the above table, we can estimate that (by weight) roughly 8 per cent of all food intended for human consumption in both the customer and staff restaurants on the day of the waste audit was wasted, either in the kitchen or on customer plated. In other words:

$$((K+P) / F)*100 = 8$$

## Europe B

In Europe B, on the day of the waste audit, each consumer in the customer restaurant purchased on average 4 items and each consumer in the staff restaurant purchased on average 1.2 items. Each customer ticket in the customer restaurants represents on average 2.2 people and each customer ticket in the staff restaurant represents 1 person (Food and Beverage Specialist, June 2013). Based on this, an assumption was made that each customer ticket in the customer restaurant includes on average 2 hot meals and 2 drinks and 1.4 cold meals, and each customer ticket in the staff restaurant includes on average 1 hot meal (with a side salad) and 0.2 drinks.

In the customer restaurant, the average weight of hot meals is 320 g and the average weight of cold meals is 160 g (Company Recipe Cards Europe A, obtained June 2013). We can assume the average weight of a drink is 50 g, and the average weight of a salad bar serving is also 50 g. If we exclude the weight of drinks (given drink waste is not included within the scope of this study), we can then estimate that the average weight of food served per customer ticket in the customer restaurant was 0.6 kg and the average weight of food served per customer ticket in the staff restaurant was 0.4 kg. On the day of the waste audit, 1155 customers were served in the customer restaurant and 61 customers were served in the staff restaurant. That means the estimated weight of food sold to customers is 693 kg in the customer restaurant and 25 kg in the staff restaurant.

*Total estimated weight (kg) of food consumed by customers and staff (excluding drinks) on the day of the waste audit*

	Food sold to customers (P+C)	Food wasted by customers (P)	Food consumed (C)
<b>Customer restaurant</b>	693 kg	50 kg	643 kg
<b>Staff restaurant</b>	25 kg	14.5 kg	10.5 kg
<b>Total</b>	<b>718 kg</b>	<b>64.5 kg</b>	<b>653.5 kg</b>

*Total estimated weight (kg) of food consumed and food wasted on the day of the waste audit*

	Food consumed (C)	Food wasted		Total (F)
		Pre-consumption (K)	Post-consumption (P)	
<b>Customer restaurant</b>	643 kg	20.8 kg	50.0 kg	713.8 kg
<b>Staff restaurant</b>	10.5 kg	16.2 kg	14.5 kg	41.2 kg
<b>Total</b>	<b>653.5 kg</b>	<b>37.0 kg</b>	<b>64.5 kg</b>	<b>755.0 kg</b>

Based on the above table, we can estimate that (by weight) 13 per cent of all food intended for human consumption in both the customer and staff restaurants on the day of the waste audit was wasted, either in the kitchen or on customer plates. In other words:

$$((K+P) / F)*100 = 13$$

## China A

In China, each consumer in the customer restaurant purchased, on average, 3.8 items. In the staff restaurant, each purchase is only recorded as one item (i.e. a main dish). An assumption was made that each purchase in the customer restaurant represents 2 hot dishes, 1 standard cold dish and 1 drink, and each purchase in the staff restaurant represents 1 hot meal served buffet style. One of the most popular local hot dishes in the customer restaurant weighs 489g – with 160g rice. Other local hot dishes appeared to be similar in size. As such, each customer ticket in the customer restaurant would represent 2 x 489 g, plus the average weight of a cold meal, being 160 g (excluding drinks) to a total average of 1.2 kg. A further assumption was made, based on observations, that each serving in the staff restaurant represented an average of 0.5 kg.

On an average day, the customer restaurant serves 3,120 customer tickets and the staff restaurant serves 686 customer tickets, bringing the total weight of food sold to 3,744 kg to customers and 343 kg to staff, being 3,894 kg in total.

*Total estimated weight (kg) of food consumed by customers and staff (excluding drinks) per day*

	Food sold to customers (P+C)	Food wasted by customers (P)	Food consumed (C)
<b>Total</b>	4,087 kg	1,350 kg	2,737 kg

*Total estimated weight (kg) of food consumed and food wasted per day*

	Food consumed (C)	Food wasted		Total (F)
		Pre-consumption (K)	Post-consumption (P)	
<b>Total</b>	2,737 kg	150 kg	1,350 kg	4,237 kg

Based on the above table, we can estimate that (by weight) 37 per cent of all food intended for human consumption in both the customer and staff restaurants on the day of the waste audit was wasted, either in the kitchen or on customer plates. In other words:

$$((K+P) / F)*100 = 35$$

## China B

The same format was applied to China B, where by each customer meal was assumed to weigh on average 1.2 kg and each staff member on average 0.5 kg. On an average day, the customer restaurant serves 1,604 customer tickets and the staff restaurant serves 401 customer tickets, bringing the total weight of food sold to 1,925 kg to customers and 200 kg to staff, being 2,025 kg in total.

*Total estimated weight (kg) of food consumed by customers and staff (excluding drinks) per day*

	Food sold to customers (P+C)	Food wasted by customers (P)	Food consumed (C)
<b>Total</b>	2,125 kg	360 kg	1,765 kg

*Total estimated weight (kg) of food consumed and food wasted per day*

	Food consumed (C)	Food wasted		Total (F)
		Pre-consumption (K)	Post-consumption (P)	
<b>Total</b>	1,765 kg	40 kg	360 kg	2,165 kg

Based on the above table, we can estimate that (by weight) around 18 per cent of all food intended for human consumption in both the customer and staff restaurants on the day of the waste audit was wasted, either in the kitchen or on customer plates. In other words:

$$((K+P) / F)*100 = 18$$