Abstract

Hospitality food waste represents a significant societal challenge. It is however under-researched with most studies approaching the issue from the perspective of sustainable agriculture and environmental, rather than hospitality, management. Given the specificity of hospitality operations, this is a major shortcoming which hampers understanding of the determinants of effective mitigation. This paper provides a critical, analytical account of the literature on hospitality food waste made from the viewpoint of hospitality managers. It reviews the challenges in classifying, quantifying and characterising hospitality food waste, discusses the opportunities and obstacles to its mitigation and, drawing on good business practice examples, derives a framework for managing food waste across the different areas of hospitality operations. The framework is underpinned by such determinants of effective mitigation as: core in-house competencies; training needs; initial investment costs; and potential monetary savings. The feasibility of its broader adoption by managers across the sector is discussed.

Keywords: Food waste; hospitality operations; waste management; managerial framework; sustainability.

Highlights

- First critical, analytical account of the literature on hospitality food waste and its mitigation
- Highlights challenges in food waste mitigation from the perspective of hospitality managers
- Reveals opportunities for effective mitigation of hospitality food waste
- Develops an analytical framework for hospitality food waste transformation
- Drawing on good business practices, provides a framework for managing hospitality food waste

1. Introduction

Waste is a major sustainability challenge (Thyberg and Tonjes 2016) given the substantial impact it poses on business revenues, public health and the environment (Wang *et al.* 2017). This is an issue of critical importance for the hospitality sector whose operations generate disproportionately large amounts of waste (Ball and Taleb 2011). As the hospitality sector continues to grow, it generates more waste (Massow and McAdams 2015), thus calling for the mitigation of the associated negative socio-economic and environmental repercussions (Pirani and Arafat 2016) as a means of achieving more sustainable and equitable futures (Buzby *et al.* 2014).

The 'wasteful' character of hospitality operations has been politically recognised (WRAP 2011) and the significant detrimental implications that hospitality waste holds for global ecosystem services have been acknowledged (Hu *et al.* 2016). The context of hospitality waste is broad and encompasses such categories as hazardous and non-hazardous waste (Zein *et al.* 2008 cited by Pirani and Arafat 2014), solid waste (Cummings 1992), energy waste (Erdogan and Baris 2007), water waste (Styles *et al.* 2015) and food waste (WRAP 2013). In the UK alone, hospitality operations generate over 3.4 million tonnes of waste annually (WRAP 2011) while, on a European scale, it is estimated that circa 1 kg of waste is produced daily by an average consumer of hospitality services (Bohdanowicz 2006). Evidence from outside Europe points that the issue of hospitality waste persists globally as it is equally pronounced in the national hospitality sectors of USA (Okazaki *et al.* 2008), Canada (Charlebois *et al.* 2015), Thailand (Manomaivibool 2015), China (Wang *et al.* 2017), South Africa (de Lange and Nahman 2015), Malaysia (Kasim and Ismail 2012; Papargyropoulou *et al.* 2016), Turkey (Erdogan and Baris 2007), the Bahamas (Sealey and Smith 2014) and Singapore (Grandhi and Singh 2016).

Food waste represents a major fraction of hospitality waste, both in absolute figures and in terms of the financial implications held for providers of hospitality services (WRAP 2011). In 2010, the hospitality sector across the EU produced over 12 million tonnes of food waste (Oliveira *et al.* 2016). In the UK alone, hospitality operations generated circa 3 million tonnes of food waste or 88% of the total amount of hospitality waste in 2011 (WRAP 2011). In financial terms, the overall cost of food waste for the UK hospitality sector was estimated at £2.5 billion in 2011, subsequently reaching £3 billion in 2016 (WRAP 2013). This is an equivalent of 2.3% of annual hospitality turnover in the UK (SRA 2010). For comparison, in Scandinavia, hospitality operations generate over 0.45 million tonnes of food waste per year, which makes an equally significant negative impact on the industry's financial performance and corporate image (Marthinsen *et al.* 2012). Hospitality food waste generation correlates well with tourism growth (Manomaivibool 2015). For example, in the case of Mallorca, the 1% rise in the number of tourist arrivals at a destination brings about the 1.25% increase in waste generation where food waste represents the major fraction (Arbulu *et al.* 2016). Hospitality food waste holds implications not only for the developed, but also for the developing countries where international tourism is growing and the levels of public income are increasing, thus leading to higher consumption of food outside home (Wang *et al.* 2017).

Although the issue of food waste in the hospitality sector has been repeatedly featured in the media, both in the UK and globally (see, for example, Evening Standard 2017; Gould 2016; Kirchgaessner 2016), thus raising consumer awareness of its magnitude and societal importance, it has attracted insufficient academic attention to-date. The literature review has returned a relatively small number of academic studies that deal specifically with hospitality food waste and identified a limited (geographical and operational) scope of analysis. Furthermore, most of these studies have been published in journal titles that deal with the topics of environmental management and sustainability, while the research outputs on food

waste conducted from the hospitality management perspective and published in tourism/hospitality management related journals are rare. This is a major shortcoming given the substantial differences in the vision on food waste adopted by environmental managers and hospitality managers. Indeed, in majority, hospitality managers view food waste (or any other challenge related to more efficient use of natural resources) as a short-term cost-saving opportunity while environmental managers consider food waste as a means of enhancing long-term sustainability of business operations (Kasim 2009). Although better environmental performance will inevitably lead to cost reduction, environmental considerations do not always sit high on the agenda of hospitality managers who are more concerned about short-term profit generation (Pereira-Moliner *et al.* 2012). In the case of food waste, it is therefore important to demonstrate the hospitality industry practitioners the positive impact of food waste mitigation on the immediate financial performance and corporate image of their businesses. Furthermore, limited research of food waste conducted from the perspective of hospitality managers and published in hospitality management related journals implies that the part of the academic community represented by social scientists may remain unaware of the scale of the problem of hospitality food waste and may lack appreciation of its significant negative implications. This is a logical result of the well-recognised challenge of academic 'silos' which suggests that academics tend to work in isolated environments and read journal titles that fall within the premise of their prime research discipline (Solnet 2012). In turn, the lack of academic research evidence hampers design of feasible, scientifically-grounded managerial approaches to food waste mitigation in the hospitality sector and inhibits the development of effective policy interventions in support of these approaches.

This paper contributes to knowledge by offering a critical, analytical account of the issue of hospitality food waste and discusses the opportunities and challenges of its mitigation from the hospitality management perspective. The paper is structured as follows.

Section 2 introduces the key definitions of (hospitality) food waste, strives to quantify and characterise hospitality food waste and outlines the major opportunities and challenges of its mitigation. Section 3 elaborates upon the existing approaches to management of hospitality food waste with industry-specific examples. Section 4 concludes by presenting the future outlook and outlining future research needs for food waste management in the hospitality sector.

2. Hospitality food waste: key definitions and the potential for mitigation

2.1. *Defining (food) waste*

The varied nature and the complex composition of waste pose a major challenge on its definition (Williams 1995). The EU Waste Directive describes waste as *'any substance or object which the holder discards'* (Directive 2008), thus interpreting waste as something invaluable to people. The merit of this definition has been questioned because it does not account for consumer perception of the value of waste which can be highly subjective (Cheyne and Purdue 1995). Indeed, despite being considered invaluable by one user, waste can become valuable to another user (Bontoux and Leone 1997) and the goods sold by charity shops exemplify the substantial inter-personal variations in the value assigned by consumers to waste. It can therefore be suggested that there is no such thing as ultimate waste, as the waste definition will always depend on the level of perceived usefulness of waste to its holder (Pongrácz and Pohjola 2004). Waste definition is always subjective and conditional upon the current state of the environment, technology and the political agenda (Bontoux and Leone 1997).

Waste has a number of fractions (for instance, paper, glass and metal) and physical states (for example, liquid and solid) but, in the hospitality context, food represents the largest waste category (WRAP 2011). Similar to the debate on the generic waste definition,

there is an on-going discussion on how food waste can be defined and categorised. Two major terms have been used, often interchangeably, in the literature, i.e. food loss and food waste. FAO (2015a, p.1) defines food loss as *'the decrease in quantity or quality of food … intended for human consumption that are ultimately not eaten by people or that have incurred a reduction in quality reflected in their nutritional value, economic value or food safety'*. In other words, food loss pertains to the food that amasses inadvertent changes to its physical structure (World Resource Institute-WRI 2013) through a breakdown or reduction in the food supply chain that provides food for human consumption (Parfitt *et al.* 2010). Food loss implies the by-accident wasting of food or removal of inedible parts of food in the different phases of the food supply chain with subsequent negative socio-economic and environmental repercussions (Grandhi and Singh 2016).

The notion of food waste is closely related to the concept of food loss and defined by FAO (2015a, p.1) as *'the discarding or alternative (non-food) use of food that was fit for human consumption-by choice or after the food has been left to spoil or expire as a result of negligence'*. Food waste involves food that was primarily produced for human intake but later assigned other purposes, such as animal feed and disposal (FAO 2015a), on account of it not being consumed by humans (Okazaki *et al.* 2008). Moreover, it is defined as food that was edible at disposal (Buzby *et al.* 2014) and spoiled food prior to being disposed of (Thyberg and Tonjes 2016), due to operational inefficiencies (WRI 2013) or irresponsible behaviour of food providers and consumers (Parfitt *et al.* 2010).

The key difference between the terms 'food loss' and 'food waste' is thus in that the former is characterised by largely unintentional occurrence while the latter arises due to both, unintentional and deliberate, human actions. Hence, based on the level of human involvement in its generation, food waste is categorised as avoidable, unavoidable and possibly avoidable (WRAP 2013). It is further divided into pre-consumer (agriculture, manufacturing,

distribution and retail) or post-consumer (household) food waste, depending on the stage of its occurrence in the food supply chain (Legrand *et al.* 2017). The term 'wasted food' has recently been proposed instead of 'food waste' to emphasise that food has been wasted by someone, rather than it has become waste on its own (Neff *et al.* 2015). All food waste definitions underline the inability of humans to eat food that was initially designed for consumption (Wang *et al.* 2017).

2.2. *Hospitality food waste*

The substantial amounts of food waste produced within the national food supply chains have been recognised and the detrimental effect of food waste on the long-term, global socio-economic and environmental sustainability has been acknowledged (Garrone *et al.* 2014). The largest share of food waste is produced by consumers, thus explaining why household food waste has been a prime object of academic interest to-date (Graham-Rowe *et al.* 2014; Katajajuuri *et al.* 2014; Parizeau *et al.* 2015). The issue of food waste production in the pre-consumer phases of the national food supply chains has attracted less attention. While the issue of food waste is increasingly considered in the context of agriculture (Griffin *et al.* 2009; Hodges *et al.* 2011) and grocery retail (Eriksson *et al.* 2012; Filimonau and Gherbin 2017; Mena *et al.* 2011), the hospitality sector has largely been excluded from analysis (Papargyropoulou *et al.* 2016; Pirani and Arafat 2014; 2016). This calls for a change given that hospitality enterprises generate increasingly larger amounts of food waste due to the rise in consumer disposable income and the growing frequency of food consumption out-of-home. Furthermore, food distribution and retail plays an important role as the center of gravity in the national food supply chains by connecting suppliers and consumers (Eriksson *et al.* 2012). Directly or indirectly, hospitality enterprises can influence consumer choice to make it more responsible (Filimonau *et al.* 2017). This emphasises the need for in-depth research on the issue of food waste in the hospitality context with an aim of identifying the

key operational areas that should be targeted for mitigation and outlining good business practice examples.

Table 1 highlights the evolution of academic research on hospitality food waste. It is built on the outcome of a systematic literature review undertaken in line with the guidelines in Montori *et al.* (2003). First, the subject specific literature was searched via Google Scholar, a popular citation-based academic search platform, in September-October 2017 and then, following the feedback from peer-review, in August 2018. To ensure a comprehensive outlook, the following keywords were employed: hospitality food waste OR restaurant food waste OR hotel food waste OR catering food waste OR hospitality food loss. The OR operator was used to make search 'all inclusive' given a range of hospitality food waste definitions cited in the literature, as per above. The references of the articles identified via this search were subsequently analysed to reveal those of relevance to the subject topic. Second, each identified article was carefully read and its content meticulously analysed by two academics to determine its fitness for review and to develop a framework for critical evaluation of reported results. Only full-length articles published in peer-reviewed academic journals were included in the review. The 'grey' literature, unpublished research and non-peer reviewed studies were excluded.

[Insert Table 1 here]

Figure 1 illustrates the framework of critical evaluation adopted in this study. The rationale behind is theory-driven and as follows: from the organisational and stakeholder theory perspective, mitigation of any (environmental) impact requires understanding of its importance by people who are familiar with the issue and capable of making decisions on behalf of a business (Heath and Norman 2004). When applied to hospitality food waste, hospitality managers represent such people as not only they define what food to cook and how to serve it, but are also in charge of decision-making on the ground. This includes the

decisions on food waste management. To better understand the importance of hospitality food waste and to engage in its mitigation, hospitality managers need to reflect upon their knowledge and experience of dealing with this issue, which is in line with reflection-in-action theory (Martin-Rios *et al.* 2018). This reflection requires managerial comprehension of the 1) scale and scope; and the 2) underlying causes of hospitality food waste generation, the core elements of environmental impact assessment (Filimonau *et al.* 2011), see Layers 1 and 2 of the framework, Figure 1. To establish the scale and scope of hospitality food waste, it is important to accurately measure (quantify) and describe (characterise) it. The underlying causes of hospitality food waste generation are linked to the challenges of effective mitigation (Layer 3, Figure 1). For example, irresponsible consumer behaviour brings about large food wastage but managing consumer behaviour in the hospitality context is difficult due to high competition, volatile customer loyalty and limited in-house resources. This suggests that the challenges of food waste mitigation can be categorised as being external and internal to hospitality businesses, depending on the extent of control that hospitality managers can execute towards them. Effectively, these challenges are the costs to businesses that need to be carefully evaluated by hospitality managers when deciding on mitigation, as proposed by corporate social responsibility (CSR) theory (McWilliams and Siegel 2001). Concurrently, the willingness of hospitality managers to address these challenges is determined by their comprehension of the value/benefits of food waste mitigation. The value is represented by the opportunities (Layer 3, Figure 1) that should be showcased to hospitality managers to warrant support for food waste mitigation campaigns which is, again, in line with theory of CSR (McWilliams and Siegel 2001). When capitalizing upon these opportunities via on-the-ground action (Layer 4, Figure 1), hospitality managers not only minimise food waste, but also become innovators within the sector. This brings multiple advantages in terms of

improved consumer engagement, refined corporate image and enhanced revenue generation, as suggested by innovation theory (Victorino *et al.* 2005).

[Insert Figure 1 here]

The review identified a relatively small number of studies on hospitality food waste management published since 1992 (n=47), Table 1, with almost half (n=22) published after 2015. This pinpoints an important knowledge gap and a rapidly developing research field given the growing importance of hospitality food waste as a global societal challenge. The yet limited research can be partially explained by the complexity of the hospitality sector, both in operational and geographical terms, which hinders collection of primary data. Indeed, due to restricted in-house resources, many hospitality enterprises do not always have the means to obtain primary data on food waste; they can further be reluctant to share collected data due to the perceived corporate sensitivity of this topic (Christ and Burritt 2017). Furthermore, Table 1 suggests that most studies have attempted to quantify and characterise the food waste flows in the hospitality sector while the causes and effects of hospitality food waste generation alongside the managerial approaches to its mitigation have been less examined. More research is necessary to identify the main barriers to effective mitigation, design intervention measures to eliminate these barriers and share good business practices in hospitality food waste minimisation.

2.3. *Quantification and characterisation of hospitality food waste*

Although the issue of food waste has been recognised as critical for the long-term sustainability of the national hospitality sectors across the world (Grandhi and Singh 2016), there is insufficient information about the magnitude of hospitality food waste generation. The problem is particularly pronounced for developing countries (FAO 2015a), but even within EU there exists no single cohesive method to monitor, quantify and characterise food

waste across major economic sectors (European Commission 2015), thereby making it difficult to effectively understand the magnitude and establish trends in hospitality food waste generation. Lack of understanding inhibits design of mitigation measures, both from the managerial and policy-making perspective.

In response to this data availability challenge, a cross-sectoral, EU-wide fusion study aiming to quantify food waste has been commissioned (FUSIONS 2016). Its outcome indicates that the EU hospitality sector produces circa 12% of the overall food waste which is the third largest figure after households (53%) and food processing industries (19%). Importantly, this figure is likely to be an under-estimate as it does not include retail catering, such as coffee shops and supermarket cafes, and contract catering, such as work and hospital canteens, where the problem of food waste persists. Outside Europe, the contribution of the hospitality sector to food waste generation is equally significant. For example, Liu (2014) posits that the hospitality sector in China produces more food waste than households with similar findings reported for Malaysia (Papargyropoulou *et al.* 2016). This is due to unfavourable climatic conditions, ineffective operational and managerial procedures and logistical issues within the national hospitality sectors in many developing economies.

Hospitality food waste has been defined as food that is unwanted and disposed of, such as leftovers from guest plates and peels from meal preparation that occur during cooking (Pirani and Arafat 2016). Wang *et al.* (2017) posit that hospitality food waste should exclude non-edible items that occur during the cooking and consumption process, such as bones and seeds, residual oils, natural flavourings and colorants. This suggests that, in terms of mitigation, the focus should be on avoidable hospitality food waste (Parfitt *et al.* 2010) whose share is estimated at 73-79% of the total amount of hospitality food waste (Oliveira *et al.* 2016), thus signifying its foremost ability to incite detrimental socio-economic and environmental repercussions for hospitality enterprises if left unmanaged (Christ and Burritt

2017). Concurrently, avoidable food waste represents the only category of hospitality food waste whose production quantities can be controlled, entirely or partially, by food service providers. This is because avoidable food waste refers to food that has become unusable due to poor transportation, storage and preparation techniques (Heikkilä *et al.* 2016). It also stands for edible portions not consumed after the completion of a meal, so-called plate waste (Kantor *et al.* 1997). According to WRAP (2013), avoidable food waste in the UK hospitality sector occurs at the preparation (45%) and consumption (34%) stages, but is also due to spoilage (which includes food that has passed its 'use by' date) in the process of handling (21%). In a study by the UK's Sustainable Restaurant Association-SRA (2010), most of avoidable food waste in London restaurants was generated during food preparation (65%) followed by consumer plates (30%), and due to spoilage (5%). In terms of characterisation, despite significant cross-sectoral and geographical differences, the major fractions of avoidable hospitality food waste are represented by (in descending order of magnitude): fruits and vegetables, cereals, fish and seafood, and meat (Papargyropoulou *et al.* 2016).

To summarise, despite the growing recognition of the magnitude of hospitality food waste, the number of studies aiming to quantify and characterise its occurrence is small. As a result, available figures are more 'guestimates', rather than the accurate assessments of major hospitality food waste flows. To better understand the scope for mitigation interventions, it is necessary to produce reliable case studies on hospitality food waste that would be representative of major hospitality sub-sectors. These case studies should in addition represent different geographies to enable understanding of the diversity of political and socio-cultural contexts alongside the determinants of food production and consumption within.

2.4. *Opportunities and challenges of hospitality food waste mitigation*

For effective mitigation, it is imperative that industry professionals understand the benefits of tackling the issue of hospitality food waste and comprehend the challenges that

can hinder mitigation (see Figure 1). By implementing more effective practices in food logistics, storage and preparation, hospitality businesses can minimise costs of waste collection and disposal (Papargyropoulou *et al.* 2014). In fact, WRAP (2013) estimates that the hospitality sector can save approximately £250 million by reducing 5% of the waste generated. Furthermore, by donating unsold food to the people in need, hospitality businesses can take advantage of tax deductions, subject to national legislation (Hotrec 2017). In turn, the above actions have potential to improve corporate image and reputation (Pirani and Arafat 2014) as involvement in food waste mitigation will portray hospitality enterprises as good corporate citizens that aim to combat such global challenges as food security, environmental conservation and poverty reduction (Thyberg and Tonjes 2016).

Improved consumer loyalty is another prospective benefit of hospitality food waste mitigation (Kasim and Ismail 2012). Consumer awareness of the negative socio-economic and environmental repercussions of hospitality food waste is growing (WRAP 2013). Unilever Food Solutions (2011) argue that over 60% of consumers in both developed and developing countries are interested in knowing how much food waste hospitality businesses generate and how they handle this challenge, while 70% are willing to pay more to hospitality enterprises that practice food waste mitigation.

Food waste mitigation can make a positive impact on staff. Employees have better knowledge on the quantity and the character of hospitality food waste and can therefore identify the key operational areas for intervention (Bohdanowicz *et al.* 2011). There is evidence pointing that staff, who have been made aware of the severe impact of hospitality food waste through training and communication, are more likely to engage in food waste minimisation and share this information with the customers (Bohdanowicz 2006; WRAP 2013). Indeed, through interactive marketing, employees are better positioned to dialogue

with consumers to raise public awareness of hospitality food waste, ‘nudge’ more responsible consumer food choice and encourage preventative behaviour.

However, aside from holding multiple opportunities, staff can also hinder hospitality food waste mitigation. The hindrance can originate from a lack of training, knowledge and provision of the necessary resources to encourage employees’ involvement in mitigation. This is evident, for example, through the retention of hospitality operational practices that delay and prevent employees from adhering, such as stock rotation (Charlebois *et al.* 2015). Employees without training on the importance of these operational practices for food waste minimisation can be reluctant to engage. This can obstruct any progress toward mitigation, thus the importance of providing training and re-training to embrace new techniques and strategies to reduce hospitality food waste (Sealey and Smith 2014).

Suppliers are integral to the success of hospitality businesses, and can create challenges for food waste mitigation. Communication is a necessary component for bargaining and building trust with suppliers (Heikklia *et al.* 2016), as each establishment has specific requirements for successful execution of kitchen processes. However, challenges can arise when suppliers have control of the market and can dictate the requirements for delivered products, such as the volume and the frequency of food deliveries. For instance, the ‘bullwhip effect’ can create excessive product inventories in hospitality enterprises that often get wasted in the case of fresh produce (Mena *et al.* 2011).

Another challenge is imposed by corporate policies. The top down managerial approach can create strict in-house policies (for example, on food safety) that managers and staff are bound to replicate. For instance, corporate policies for buffet items often dictate that the food which has not been consumed during one meal period cannot be used during another and should therefore be thrown away (Papargyropoulou *et al.* 2016). Instead, corporate policies could enable this food to be re-used or utilised for (staff) meals. All in all, with

hospitality corporate policies being focused on guest safety and satisfaction, it becomes challenging for managers and staff to engage in food waste mitigation (Charlebois *et al.* 2015). Concurrently, Thyberg and Tonjes (2016) posit that no single corporate policy can solve food waste; instead, there is a need for rather customised, flexible and ad-hoc solutions that managers and staff can tailor to varying situations and apply on the ground, if and when required.

Governmental policies and national legislation can challenge the ability and hamper the willingness of hospitality businesses to mitigate food waste. Overly stringent food safety standards can discourage the hospitality sector from preventing food waste generation as policies prioritise disposal and prohibit redistribution of unsold food (Thyberg and Tonjes 2016). For instance, by law, hospitality businesses are often required to dispose of food items that have been incorrectly labelled or damaged during transportation and storage, with policies in this case facilitating waste generation, rather than preventing its occurrence (Heikkilä *et al.* 2016). Furthermore, strict legislation can hinder the redistribution of excess food. In the case of food donations, for example, legislation fails to protect food donors, making them liable for any illness caused by donated food (Thyberg and Tonjes 2016). This liability risk coupled with the absence of tax relief for food donations have deterred hospitality businesses in the UK, for example, from donating unsold food (Deloitte 2014).

Consumer represents another obstacle. Poor public knowledge of the magnitude of hospitality food waste and insufficient consumer understanding of its detrimental implications for the environment and society leads to irresponsible behavioural patterns (Russell *et al.* 2017). Societal status prejudices and social norms hamper consumers from requesting takeaway boxes/doggy bags for leftover food (Sirieix *et al.* 2017). Although provision of doggy bags may simply shift the responsibility of managing food waste from hospitality businesses to consumers, it is considered a feasible mitigation option if there are

no alternatives available and given that a large share of hospitality food waste originates from consumer plates.

National culture may play a role in irresponsible food consumption. For example, within the Chinese ‘mianzi’ cultural trait, food represents a means to build upon the social relationship, which results in the host ordering more food than necessary when eating out to show their hospitability towards the guest (Wang *et al.* 2017). Further, food is often a symbol of national identity (Gossling *et al.* 2011) and national culture may determine how consumers perceive wasted food (Heikkilä *et al.* 2016). Nations with strong food cultures assign stronger value to food implying lower probability of food wastage in hospitality (Thyberg and Tonjes 2016). Lastly, national culture affects the fundamental classification of hospitality food waste as some items are considered edible in certain cultures while they are deemed inedible in the others. For instance, cattle hooves are consumed in Africa and chicken feet is edible in China and the Caribbean, but not in Europe.

In summary, there are numerous benefits of engaging in food waste prevention and mitigation for hospitality managers. When applied effectively, these benefits translate into business opportunities that can outweigh the manifold challenges of hospitality food waste mitigation. It is important that hospitality managers critically evaluate these opportunities and challenges to appreciate the importance of food waste mitigation as a driver of refined financial performance, enhanced corporate image and improved conservation of natural resources. Examples of good business practice in minimising hospitality food waste can effectively showcase the benefits of food waste mitigation to the industry practitioners, thus indicating the value of their adoption to managers.

3. Hospitality food waste: approaches to mitigation

Waste minimisation focuses on averting the generation of waste at the source (Pongrácz and Pohjola 2004). It is an ultimate goal of waste management which strives *'to regulate the movement of wastes from the point of generation to the point of ultimate disposal'* (Wilson and Nair 1992 cited by Ball and Taleb 2011, p. 13) in order to make better use and/or recirculate resources, enable environmental conservation and enhance the levels of public health (Neff *et al.* 2015). Management of hospitality food waste should thus focus on all stages of the food chain, starting with agriculture, through food manufacturing, transport, storage and distribution, to consumption (Cheyne and Purdue 1995).

When applied to the hospitality context, the principle of the food chain suggests that food waste mitigation in hospitality businesses should focus on three main operational stages: pre-kitchen, kitchen and post-kitchen. At the pre-kitchen stage, managers should strive to optimise business procurement by investing into more accurate demand forecasting with subsequent more effective stock management. This is to avoid excessive amounts of food being stored, thus preventing it from spoilage. This can be achieved via, for example, close work with suppliers and careful menu design. At the kitchen stage, managers need to look at the processes of handling, cooking and serving food. At the post-kitchen stage food waste mitigation requires pro-active work with customers, use of advanced methods for excess food redistribution (including technology innovations) and managerial and corporate openness to more effective approaches to food waste disposal, among others (Figure 1).

In recognition of the critical importance of hospitality food waste, the food waste hierarchy was developed to support food waste management practices in the hospitality sector (Papargyropoulou *et al.* 2014). The hierarchy follows the Waste Framework Directive adopted by the European Commission (2015) and is underpinned by the principle that prevention is better than cure, thus advocating that not producing food waste in the first place represents the ideal approach to hospitality food waste management (WRAP 2011). The

hierarchy is known under different names in different geographies. WRAP (2017b) refers to it as the Food and Material Hierarchy, while the US Environmental Protection Agency refers to it as the Food Recovery Hierarchy (EPA 2017). In Asia, the hierarchy is known as the 3R's (Reduce-Reuse-Recycle) managerial framework (OECD 2010). It is important that industry professionals understand how the hospitality food waste hierarchy operates and aim to implement its specific stages in hospitality operations as set by the hierarchy in the order of priority. Figure 2 uses the hierarchy as a basis for the development of the food waste transformation framework which can be utilised by hospitality managers when designing mitigation interventions. The proposed managerial framework outlines the major stages in food waste minimisation, provides examples of concrete actions to be adopted by managers at each stage and offers an overview of the key, internal and external, factors that can enable and inhibit the successful adoption of these actions.

[Insert Figure 2 here]

Although the hospitality food waste management hierarchy has been proposed, there is no standardised method to quantify, characterise and reduce the amounts of hospitality food waste. Furthermore, there is no inventory of good business practice examples and case studies that industry professionals could avail of when designing the corporate agenda on hospitality food waste management. There is sufficient evidence of practices that have been successfully applied to minimise hospitality food waste in the academic and 'grey' literature, but these remain dispersed and require better systematisation (Pirani and Arafat 2016). Among these practices are the re-design of kitchen processes (SRA 2010; WRAP 2011; Duursma *et al.* 2016), consumer awareness raising programmes (FAO 2015a; LFHW 2017), application of food recovery, recycling (WRAP 2013; Thyberg and Tonjes 2016) and food redistribution (for example, via donation) techniques (FWRA 2015; FUSIONS 2016), and the

development of and the use of technology to optimise hospitality operations (Gould 2016; TGTG 2017; Unilever 2017).

3.1. Re-design of kitchen processes

The largest amounts of food in hospitality operations are wasted at the stages of food preparation and consumption (WRAP 2011), thus pointing prime mitigation targets. As an initial step, the measures to monitor the type and the quantity of food items wasted during cooking and to audit plate waste should be undertaken. These measures will indicate what operational processes should be adjusted to minimise food wastage, thus contributing to better menu planning. Menu streamlining can be undertaken as a result, especially if there are items that are unpopular and bring about extensive food wastage (Papargyropoulou *et al.* 2016). As a good business practice, in the UK, the Wahaca Mexican restaurant group monitors food waste in the kitchen and analyses customer plate waste regularly to understand what items are being left and further alter the cooking processes to reduce food waste and build on the customer experience (WRAP 2017c).

Cooking and menu planning can also involve the more frequent use of seasonal items (Gossling *et al.* 2011) and offering customers more flexibility in terms of preferred portion size, thus applying portion control (Kallbekken and Saelen 2013). For example, in De Pleats Restaurant (The Netherlands), portions are designed to suit a variety of clients and, in addition to smaller portions designed for children, this hospitality business offers smaller portions to female and senior guests (Duursma *et al.* 2016). This represents a good business approach to not only minimise the occurrence of food wastage, but also to manage revenues in the context of a la carte service, as smaller portions can be priced at the lower end (WRI 2013). Portion control can further aid hospitality enterprises in obtaining reputational gains as it can be seen by consumers as a means of obesity prevention (Wansink and van Ittersum 2013). However, the decision to control portion size in hospitality business should be taken

with caution, and only after careful consultations with consumers, as some guests can see 'less value for money' in smaller meals (Young and Nestle 2002) which may, in turn, negatively affect their experience.

Food waste monitoring may bring about the re-design of the entire cooking and dining experience. Gössling *et al.* (2011) argue that the feasibility of offering buffets should be reconsidered by hospitality managers. This is because buffets have originally been designed to encourage customers to take solely what they can consume. Buffets have however developed a considerable side effect in a way that they encourage consumption of uneaten food with subsequent wastage. Papargyropoulou *et al.* (2016) suggest that the use of a la carte service, rather than a buffet service, can prevent hospitality food waste. Although a la carte menus can also generate food waste, employees can however more effectively influence consumer choice during the a la carte dining experience. Indeed, buffets are operated on a walk-in basis, rather than by reservation, which limits the kitchen staff's ability to determine exact customer numbers, thus producing food surplus to meet the needs of potential guests or when guests exceed forecast numbers (Pirani and Arafat 2014). When replacing buffet service with a la carte service is not feasible, hospitality businesses should consider the option of using smaller plate sizes for better portion control and food waste management (Kallbekken and Saelen 2013). The use of smaller plates must however be coupled with clear labeling to inform customers that they can return for additional servings. An important aspect of this measure is tied to raising staff awareness and holding dialogues with consumers to ensure that both stakeholders understand their role in reducing food waste (Papargyropoulou *et al.* 2016).

Lastly, the re-design of menus and cooking/dining experiences in the result of monitoring food wastage should be supplemented with effective demand forecasting and revenue management techniques (Gössling *et al.* 2011). These will enable industry

professionals to order as much food as necessary, thus preventing wastage from occurrence at the point when food enters the business premises. Regular stock audits should also be applied. For instance, the first-in-first-out technique should be used, allowing food items in storage to be used before new items (Charlebois *et al.* 2015).

3.2. Consumer awareness raising programmes

The growing recognition of the significance of the issue of food waste has led to the development of public awareness programmes aiming to assist managers and engage consumers in mitigation. Although no dedicated initiatives have been designed for hospitality food waste mitigation, some programmes have integrated hospitality food waste into their agenda. For instance, the Save Food Initiative was introduced by FAO in 2011 focusing on the necessity of business and consumer collaboration and coordination, raising customer awareness, promoting research on food waste mitigation, also in the context of hospitality (FAO 2015a; Save Food Initiative 2017). Likewise, The European Commission have committed to reduce food waste by investing into the creation of a toolkit which offers guidance on the techniques for food waste quantification and characterisation and highlights consumer-focused approaches to food waste management, including good business practices across various sectors (European Commission 2015). The industry professionals have also developed their own programmes for hospitality food waste mitigation (Think.eat.save 2014; United against waste 2017). For example, the Love Food Hate Waste (LFHW) initiative launched in 2015 in the UK aims to educate consumers on the negative repercussions of food waste across various economic sectors, including hospitality. It further strives to develop business partnerships to raise consumer awareness of the impacts of food waste (LFHW 2017). Among hospitality-related activities, the LFHW initiative educates customers on the importance of applying portion control and using smaller plates and take away boxes for food waste mitigation. Non-governmental and industry associations (for example, SRA and

WRAP in the UK) support mitigation of hospitality food waste by monitoring the magnitude of food waste and recommending good business practices, including those with a focus on customers.

3.3. Redistribution of unsold food

The rise of the sharing economy has revealed opportunities for redistributing unsold food as a means of food waste mitigation in the hospitality sector. In 2013, over 500,000 tonnes of excess food were redirected to charity organisations by grocery retailers, hospitality businesses and individual consumers worldwide (FAO 2015b). To facilitate redistribution in the USA, the Food Waste Reduction Alliance (FWRA), a strategic partnership between the National Restaurant Association, the Grocery Manufacturers' Association and the Food Marketing Institute, was created (FWRA 2015). Many hospitality enterprises in the USA (for instance, Starbucks) have further partnered with Feeding America and Food Donation Connection to donate unsold food to the people in need (Garfield 2016). Likewise, in the UK, the Courtauld Commitment has united grocery retailers and hospitality enterprises in a voluntary attempt to develop effective ways to manage surplus food. The initiative has seen businesses developing partnerships with charities and community groups to donate unsold food to vulnerable population groups (WRAP 2017d). For instance, circa 100 KFC restaurants in the UK donate over 70,000 meals to charities in the UK every month (WRAP 2017a). Similar initiatives exist in developing countries where the impact of food redistribution is arguably more pronounced due to the yet substantial levels of social segregation and societal inequality. The work of ThaiHarvestSOS in Thailand (ThaiHarvestSOS 2018) and Pit Stop Community Café in Malaysia (Pit Stop Community Café 2018) are good examples of how the redistribution of unsold hospitality food can enable environmental conservation and feed the impoverished.

Although Papargyropoulou *et al.* (2014) highlight donation of excess food as an attractive option to reduce hospitality food waste, national food safety standards and sanitary laws can inhibit its implementation. For example, due to legal challenges, only 32.3% and 17.4% of excess hospitality food are donated in Poland and Sweden, respectively (Bohdanowicz 2006). However, food donation is increasingly considered a feasible approach to hospitality food waste mitigation (FUSIONS 2016). For instance, France and Italy have legally reinforced donations of unsold food in the sectors of grocery retail and hospitality with businesses being penalised for non-compliance in France (Chrisafis 2016) and incentivised in Italy (Kirchgaessner 2016).

Despite the growing popularity of food donations as a means to mitigate hospitality food waste, they should be applied with caution. On the one hand, donations cannot only reduce the amounts of wasted food, thus minimising operational costs, but also alleviate poverty. On the other hand, food donations can just shift responsibility for managing excess food from hospitality businesses to the charities and food banks. There are further resource implications for the charities and food banks that do not always possess the necessary equipment, labour and time to safely store and redistribute unsold hospitality food.

3.4. Use of technology

Technological innovations have aided in the mitigation of hospitality food waste. The advances in forecasting and capacity management modelling have enabled hospitality businesses to more accurately match food supply and demand (Parfitt *et al.* 2010). Furthermore, smartphone apps have been developed to assist industry professionals in quantifying the volume and characterising the content of food wasted with the design of subsequent mitigation measures. For instance, Unilever Food Solutions (2017) developed a "Wise Up on Waste" smart meter app for chefs to measure, monitor and manage food waste in commercial kitchens. The trials show that the adopters of such technological innovations

can reduce food wastage significantly (Gould 2016). For example, the Crieff Hydro's Meikle restaurant in the UK, which trialled a similar smart meter designed by WRAP, reported food waste reduction by 31% in weight and by 43% in cost (WRAP 2014). From a consumer viewpoint, the pan-European "Too Good To Go (TGTG)" smartphone app enables customers to purchase heavily discounted restaurant meals at the end of a daily service, thus minimising the amount of food being thrown away, reducing waste disposal costs and increasing end-of-day sales for participating businesses (TGTG 2017).

3.5. Recycling/Composting

The hospitality food waste hierarchy pinpoints the importance of recycling/composting to handle the food waste whose occurrence cannot be prevented at the source and/or which cannot be subsequently redistributed (Hu *et al.* 2016). Although the notions 'food recycling' and 'food composting' have been used interchangeably within the literature, they do not necessarily hold the same meaning. The hospitality food waste hierarchy highlights food composting as a subset of food recycling; in turn, food recycling is understood as a broad set of processes that have the ability to not only compost food, but also to alter food into useful items (Cummings 1997). WRAP (2013) posit that, while being one of the 'last resorts' in pro-active food waste management, recycling/composting food waste is preferable to landfill disposal as it minimises costs and environmental impacts once executed effectively. As a good business practice, recycling/composting is however not popular in Europe due to the need to comply with EU animal by-product regulations (GOV.UK 2014). For instance, strict laws hamper the use of hospitality food waste for animal feed in the UK as a result of the 2001 Foot and mouth disease outbreak (Bates 2016).

Composting can reform the composition of food waste for subsequent use as fertilizer (Singh *et al.* 2014). Despite the environmental and economic benefits of composting, only 6% of UK hospitality businesses compost wasted food (WRAP 2011). In contrast, 67%

hospitality businesses in the UAE engage in composting, thus making it a prime measure for food waste mitigation (Pirani and Arafat 2016). The feasibility of composting food waste has been recognised worldwide. For instance, Sandals Emerald Bay in Bahamas composts over 70 tonnes of food waste within a seven month period (Sealey and Smith 2014) while VideVerde in Brazil collects hospitality food waste to transform it into compost and then sell as fertilizer (Bragatti 2012). When composting is not feasible, on-site anaerobic digestion of food waste can be adopted. The application of this approach in the context of hospitality can however be hampered by space constraints, high initial investment costs and under-developed market for the by-product of anaerobic digestion (Mbuligwe and Kassenga 2004).

To summarise, a number of programmes have been developed across the world to mitigate hospitality food waste through the provision of preventative strategies, raising consumer awareness, redistribution of excess food, and recycling/composting. These programmes have been designed to execute a ripple effect as to encourage industry professionals to minimise environmental impacts while increasing revenue and customer satisfaction. There is evidence of the growing interest in the adoption of food waste management practices by hospitality enterprises. This interest can be facilitated by exemplifying the benefits of food waste mitigation, demonstrating the tangible effect of its application and outlining good business practices as adopted in various political and socio-economic contexts. Figure 3 serves the purpose of summarizing specific management actions, core in-house competencies and financial resources required for hospitality food waste mitigation and presenting these actions in the form of a stand-alone managerial framework. The proposed framework should not be considered complete as its elements may not necessarily apply to all hospitality ventures across the sector and around the world. Instead, the framework can be used as a basis for its subsequent development and adoption by hospitality managers to fit the particular contexts that hospitality enterprises operate in. It can

be further refined to meet the business objectives and match the resources of specific hospitality ventures.

[Insert Figure 3 here]

4. Conclusions

Hospitality food waste is a growing global challenge whose mitigation requires commitment of multiple stakeholders. Despite its political, socio-economic and environmental significance, the issue of hospitality food waste remains academically under-studied, especially from the perspective of industry professionals. This hampers comprehension of the true magnitude of the hospitality food waste challenge by policy-makers, practitioners, academics and consumers and hinders design of effective mitigation measures.

This review paper provides a critical, analytical account of hospitality food waste by elaborating on the challenges attributed to its classification, quantification, characterization and management. The literature revealed that the key definitions retain ambiguity while there is no standardised methodology on how to assess the volume and appraise the content of hospitality food waste. While there is good evidence of successful mitigation as applied by hospitality enterprises across the globe, there is no comprehensive inventory of good business practices which could be adopted and utilised as a universal, all-in-one managerial framework. The absence of such a framework hampers the application of food waste mitigation measures by hospitality enterprises worldwide.

This paper contributes to theory with a first draft of the managerial framework for hospitality food waste mitigation. This framework is underpinned by a critical review of the extant literature on hospitality food waste management. The framework has been designed to aid hospitality managers in understanding the major causes of hospitality food waste

generation alongside the opportunities and challenges of its effective mitigation across the different areas of hospitality operations. It is anticipated that the framework will be further developed and refined by academics and industry professionals for broader implementation across the hospitality sector. The development should consider, inter alia, the optimisation of the framework for use in the context of different types of hospitality businesses. For example, in fine dining, the amount of food waste generated in cooking (kitchen stage) is more critical than the amount of food waste produced by consumers. This is due to more sophisticated cooking and plating techniques used, but also because of smaller food portions. This should be considered and the managerial framework proposed in this study should be refined accordingly.

Future academic research should harmonise the different methodologies for hospitality food waste quantification and characterisation. This is to outline the most effective assessment technique and to test the feasibility of its application in various political and socio-economic contexts. This is especially important given that available figures on hospitality food waste in developed countries are not always precise while these are often non-existent in developing and transitional economies. Due to the focus of the literature on the developed world, there is thus an urgent need for stand-alone and/or comparative studies on hospitality food waste and its mitigation in the ‘non-western’ contexts where tourism is on the rise and the frequency of dining out is gradually growing. Next, managerial approaches to hospitality food waste mitigation should be studied in detail in the context of both, developed and developing, economies. These can subsequently be adopted for the application by industry professionals across the globe, subject to accounting for national, regional and local conditions. Lastly, the effect of consumer knowledge, behaviour and habits, especially the role of national culture, on hospitality food waste generation and mitigation should be examined through empirical research, such as via large-scale consumer surveys and real life

industry experiments. There is anecdotal evidence that consumer awareness of hospitality food waste is growing, which underlines the policymaking and managerial importance of understanding how hospitality customers can be ‘nudged’ for more active engagement in hospitality food waste prevention and mitigation.

References

Arbulu, I., Lozano, J., and Rey-Maquieira, J., 2016. Waste generation flows and tourism growth. *Journal of Industrial Ecology*, 21(2), 272-281.

Ball, S., and Taleb, A.M., 2011. Benchmarking waste disposal in the Egyptian hotel industry. *Tourism and Hospitality Research*, 11(1), 1-18.

Bates, C., 2016. When foot-and-mouth disease stopped the UK in its tracks. BBC News Magazine, 17 February 2016. Available from: http://www.bbc.co.uk/news/magazine-35581830 (Accessed 8 September 2017).

Betz, A., Buchli, J., Gobel, C., and Muller, C., 2015. Food waste in the Swiss food service industry-Magnitude and potential for reduction. *Waste Management*, 35, 218-226.

Bohdanowicz, P., 2006. Environmental awareness and initiatives in the swedish and polish hotel industries-survey results. *International Journal of Hospitality Management*, 25(4), 662-682.

Bohdanowicz, P., Zientara, P., and Novotna, E., 2011. International hotel chains and environmental protection: an analysis of Hilton's We Care! Programme (Europe 2006-2008). *Journal of Sustainable Tourism*, 19(7), 797-816.

Bontoux, L., and Leone, F., 1997. *The legal definition of waste and its impact on waste management in Europe.* Institute for Prospective Technological Studies, Luxembourg.

Bragatti, M., 2012. Recycling food for Brazil's high rollers. Deutsche Welle (DW), 28 December 2012. Available from: http://www.dw.com/en/recycling-food-for-brazils-high-rollers/a-16453553 (Accessed 8 September 2017).

Buzby, J.C., Wells, H.F., and Hyman, J., 2014. *The estimated amount, value and calories of postharvest food losses at the retail and consumer levels in the United States*. United States

Department of Agriculture, Economic Research Service, Washington.

Chalak, A., Abou-Daher, C., and Abiad, M.G., 2018. Generation of food waste in the hospitality and food retail and wholesale sectors: lessons from developed economies. *Food Security*, in press, https://doi.org/10.1007/s12571-018-0841-0

Charlebois, S., Creedy, A.; and Massow, M.V., 2015. Back of house – focused study on food waste in fine dining: the case of Delish restaurants. *International Journal of Culture, Tourism and Hospitality Research*, 9(3), 278-291.

Cheyne, I., and Purdue, M., 1995. Fitting definition to purpose: the search for a satisfactory definition of waste. *Journal of Environmental Law*, 7(2), 149-168.

Chrisafis, A., 2016. French law forbids food waste by supermarkets. *The Guardian*, 4 February 2016. Available from: https://www.theguardian.com/world/2016/feb/04/french-law-forbids-food-waste-by-supermarkets (Accessed 24 August 2017).

Christ, K.L., and Burritt, R., 2017. Material flow cost accounting for food waste in the restaurant industry. *British Food Journal*, 119(3), 600-612.

Cummings, L.E., 1992. Hospitality solid waste minimization: a global frame. *International Journal of Hospitality Management*, 11(3), 255-267.

Cummings, L.E., 1997. Waste minimisation supporting urban tourism sustainability: a mega-resort case study. *Journal of Sustainable Tourism*, 5(2), 93-108.

Deloitte, 2014. *Comparative Study on EU Member States' Legislation and Practices on Food Donation*. European Economic and Social Committee, Bruxelles.

De Lange, W., and Nahman, A., 2015. Costs of food waste in South Africa: incorporating inedible food waste. *Waste Management*, 40, 167-172.

Derqui, B., and Fernandez, V., 2017. The opportunity of tracking food waste in school canteens: Guidelines for self-assessment. *Waste Management,* 69, 431-44.

Derqui, B., Fernandez, V., and Fayos, T., 2018. Towards more sustainable food systems. Addressing food waste at school canteens. *Appetite,* 129, 1-11.

Directive, 2008. Directive 2008/98/EC of the European Parliament and of the council on waste and repealing certain directives. *Official journal of the European Union*, L312/3. Available from: http://eur-lex.europa.eu/legal-content/en/ALL/?uri=CELEX:32008L0098.

Duursma, G., Vrenegoor, F., and Kobus, S., 2016. Food waste reduction at Restaurant De Pleats: small steps for mankind. *Research in Hospitality Management*, 6(1), 95-100.

El-Mobaidh, A.M., Taha, M.A.R., and Lassheen, N.K., 2006. Classification of in-flight catering wastes in Egypt air flights and its potential as energy source (chemical approach). *Waste Management*, 26(6), 587-591.

Engstrom, R.A., and Carlsson-Kanyama, A., 2004. Food losses in food service institutions examples from Sweden. *Food Policy*, 29(3), 203-213.

Environmental Protection Agency (EPA), 2017. *Sustainable management of food*. EPA, Washington. Available from: https://www.epa.gov/sustainable-management-food/sustainable-management-food-basics (Accessed 5 August 2017).

Erdogan, N., and Baris, E., 2007. Environmental protection programs and conservation practices of hotels in Ankara, Turkey. *Tourism Management*, 28, 604-614.

Eriksson, M., Strid, I., and Hansson, P-A., 2012. Food losses in six Swedish retail stores: wastage of fruit and vegetables in relation to quantities delivered. *Resources, Conservation and Recycling*, 68, 14-20.

Eriksson, M., Osowski, C.P., Malefors, C., Björkman, J., and Eriksson, E., 2017. Quantification of food waste in public catering services–a case study from a Swedish municipality. *Waste Management,* 61, 415-422.

Eriksson, M., Osowski, C.P., Björkman, J., Hansson, E., Malefors, C., Eriksson, E., and Ghosh, R., 2018. The tree structure-a general framework for food waste quantification in food services. *Resources, Conservation and Recycling*, 130, 140-151.

Evening Standard, 2017. *Food for London.* Available from: https://www.standard.co.uk/news/foodforlondon (Accessed 06 November 2017).

European Commission, 2015. *Closing the loop- an EU action plan for the circular economy*. European Commission, Brussels.

Falasconi, L., Vittuari, M., Politano, A., and Segre, A., 2015. Food Waste in School Catering: An Italian Case Study. *Sustainability,* 7(11), 14745-14760.

Ferreira, M., Martins, M.L., and Rocha, A., 2013. Food waste as an index of foodservice quality. *British Food Journal,* 115(11), 1628-1637.

Filimonau, V., Dickinson, J.E. Robbins, D., and Reddy, M.V., 2011. A critical review of methods for tourism climate change appraisal: life cycle assessment as a new approach, Journal of Sustainable Tourism, 19(3), 301-324.

Filimonau, V., and Gherbin, A., 2017. An exploratory study of food waste management practices in the UK grocery retail sector. *Journal of Cleaner Production,* 167, 1184-1194.

Filimonau, V., Krivcova, M., and Pettit, F., 2019. An exploratory study of managerial approaches to food waste mitigation in coffee shops. *International Journal of Hospitality Management,* 76 (Part A), 48-57.

Filimonau, V., Lemmer, C., Marshall, D., and Bejjani, G., 2017. 'Nudging' as an architect of more responsible consumer choice in food service provision: The role of restaurant menu design. *Journal of Cleaner Production*, 144, 161-170.

Food and Agriculture Organisation of the United Nations (FAO), 2015a. *Global initiative on food loss and waste reduction*. FAO, Rome.

Food and Agriculture Organisation of the United Nations (FAO), 2015b. *Food losses and waste in Latin America and the Caribbean*. FAO, Rome.

Food Waste Reduction Alliance (FWRA), 2015. *Best practices and emerging solutions guide.* FWRA, Washington.

FUSIONS, 2016. *Estimates of European food waste levels*. FUSIONS, Stockholm.

Garrone, P., Melacini, M., and Perego, A., 2014. Opening the black box of food waste reduction. *Food Policy*, 46, 129-139.

Garfield, L., 2016. *Starbucks is trying a new initiative to stop wasting so much food*. Business Insider UK, 25 August 2016. Available from: http://uk.businessinsider.com/starbucks-to-donate-unsold-food-2016-8 (Accessed 5 August 2017).

Gössling, S., Garrod, B., Aall, C., Hille, J., and Peeters, P., 2011. Food management in tourism: reducing tourism's carbon foodprint. *Tourism Management*, 32, 534-543.

Gould, H., 2016. *Restaurant have a huge food waste problem; could an app help?* The Guardian, 27 May 2016. Available from: https://www.theguardian.com/sustainable-business/2016/may/27/restaurants-huge-food-waste-problem-smart-meter-winnow-hugh-fearnley-whittingstall (Accessed 5 August 2017).

GOV. UK, 2014. *Supplying and using animal by-products as farm animal feed*. Department for Environment, Food and Rural Affairs, UK. Available from:

https://www.gov.uk/guidance/supplying-and-using-animal-by-products-as-farm-animal-feed (Accessed 8 September 2017).

Graham-Rowe, E., Jessop, D.C., and Sparks, P., 2014. Identifying motivations and barriers to minimising household food waste. *Resources, Conservation and Recycling*, 84, 15-23.

Grandhi, B., and Singh, J.A., 2016. What a waste! a study of food wastage behaviour in Singapore. *Journal of Food Products Marketing*, 22(4), 471-485.

Griffin, M., Sobal, J., and Lyson, T.A., 2009. An analysis of a community food waste stream. *Agriculture and Human Values*, 26(1-2), 67-81.

Heath, J., and Norman, W., 2004. Stakeholder Theory, Corporate Governance and Public Management: What can the History of State-Run Enterprises Teach us in the Post-Enron era? *Journal of Business Ethics*, 53(3), 247-265.

Heikkilä, L., Reinikainen, A., Katajajuuri, J-M., Silvennoinen, K., and Hartikainen, H., 2016. Elements affecting food waste in the food service sector. *Waste Management*, 56, 446-453.

Hodges, R.J., Buzby, J.C., and Bennett, B., 2011. Postharvest losses and waste in developed and less developed countries: opportunities to improve resource use. *The Journal of Agricultural Science*, 149(S1), 37-45.

Hotrec Hospitality Europe, 2017. *European hospitality industry guidelines to reduce food waste and recommendations to manage food donations*. Hotrec Hospitality Europe, Belgian.

Hu, M-L., Horng, J-S., Teng, C-C., and Chou, S-F., 2016. A criteria model of restaurant energy conservation and carbon reduction in Taiwan. *Journal of Sustainable Tourism*, 21(5), 765-779.

Juvan, E., Grun, B., and Dolnicar, S., 2018. Biting Off More Than They Can Chew: Food Waste at Hotel Breakfast Buffets. *Journal of Travel Research*, 57(2), 232-242.

Kallbekken, S., and Saelen, H., 2013. Nudging hotel guests to reduce food waste as a win-win environmental measure. *Economics Letters*, 119(3), 325-327.

Kantor, L.S., Lipton, K., Manchester, A., and Oliveira, V., 1997. Estimating and addressing America's food losses. *Food Review*, 20, 2-12.

Kasim, A., 2009. Managerial attitudes towards environmental management among small and medium hotels in Kuala Lumpur. *Journal of Sustainable Tourism*, 17(6), 709-725.

Kasim, A., and Ismail, A., 2012. Environmentally friendly practices among restaurants: drivers and barriers to change. *Journal of Sustainable Tourism*, 20(4), 551-570.

Katajajuuri, J-M., Silvennoinen, K., Hartikainen, H., Heikkilä, L. and Reinikainen, A., 2014. Food waste in the Finnish food chain. *Journal of Cleaner Production*, 73, 322-329.

Kirchgaessner, S., 2016. Italy tackles food waste with law encouraging firms to donate food. The Guardian, 3 August, 2016. Available from: https://www.theguardian.com/world/2016/aug/03/italy-food-waste-law-donate-food (Accessed 24 August 2017).

Kuczman, O., Gueri, M.V.D., De Souza, S.N.M., Schirmer, W.N., Alves, H.J., Secco, D., Buratto, W.G., Ribeiro, C.B., and Hernandes, F.B., 2018. Food waste anaerobic digestion of a popular restaurant in Southern Brazil. *Journal of Cleaner Production*, 196, 382-389.

Legrand, W., Sloan, P., and Chen, J.S. 2017. *Sustainability in the hospitality industry: principles of sustainable operations*. 3rd edition. Routledge. Oxon.

Li, X.D., Poon, C.S., Lee, S.C., Chung S.S., and Luk, F., 2003. Waste reduction and recycling strategies for the in-flight services in the airline industry. *Resources, Conservation and Recycling*, 37, 87-99.

Liu, G., 2014. *Food losses and food waste in China: a first estimate* [online]. OECD Food, Agriculture and Fisheries, Paper No. 66, Paris.

Lorenz, B.A-S., Hartmann, M., and Langen, N., 2018. What makes people leave their food? The interaction of personal and situational factors leading to plate leftovers in canteens. *Appetite*, 116, 45-56.

Love Food Hate Waste, 2017. Why save food. WRAP, Oxon. Available from: https://www.lovefoodhatewaste.com/why-save-food (Accessed 5 August 2017).

Manomaivibool, P., 2015. Wasteful tourism in developing economy? a present situation and sustainable scenarios. *Resources, Conservation and Recycling*, 103, 69-76.

Marthinsen, J., Sundt, P., Kaysen, O., and Kirkevaag, K., 2012. *Prevention of food waste in restaurants, hotels, canteens and catering*. Nordic Council of Ministers, Copenhagen.

Martin-Rios, C., Demen-Meier, C., Gossling, S., and Cornuz, C., 2018.Food waste management innovations in the foodservice industry. *Waste Management*, 79, 196-206.

Massow, M.V., and McAdams, B., 2015. Table scraps: an evaluation of plate waste in restaurants. *Journal of Foodservice Business Research*, 18, 437-453.

Mbuligwe, S.E., and Kassenga, G.R., 2004. Feasibility and strategies for anaerobic digestion of solid waste for energy production in Dar es Salaam city, Tanzania. *Resources, Conservation and Recycling*, 42(2), 183-203.

McWilliams, A., and Siegel, D., 2001. Corporate Social Responsibility: A Theory of the Firm Perspective. *Academy of Management Review*, 26(1), 117–127.

Mena, C., Adenso-Diaz, B., and Yurt, O., 2011. The causes of food waste in the supplier-retailer interface: evidences from the UK and Spain. *Resources, Conservation and Recycling*, 55(6), 648-658.

Montori, V.M., Swiontkowski, M.F., and Cook, D.J., 2003. Methodologic issues in systematic reviews and meta-analyses. *Clinical Orthopaedics and Related Research,* 413, 43-54.

Neff, R.A., Spiker, M.L., and Truant, P.L., 2015. Wasted food: US consumers' reported awareness, attitudes, and behaviour. *PLOS One,* 10(6), 1-16.

Okazaki, W.K., Turn, S.Q., and Flachsbart, P.G., 2008. Characterization of food waste generators: a Hawaii case study. *Waste Management*, 28, 2483-2494.

Oliveira, B., de Moura, A.P., and Cuhna, L.M., 2016. Reducing Food Waste in the Food Service Sector as a Way to Promote Public Health and Environmental Sustainability. In: Filho, W.L., Azeiteiro, U.M., Alves, F. (Eds), *Climate Change and Health Book Subtitle: Improving Resilience and Reducing Risks*, Springer, Basel.

Organisation for Economic Cooperation and Development (OECD), 2010. *OECD environmental performance reviews: Japan 2010 - waste management and the 3R's (reduce, reuse, recycle).* OECD, Paris.

Papargyropoulou, E., Lozano, R., Steinberger, J. K., Wright, N., and Ujang, Z. B., 2014. The food waste hierarchy as a framework for the management of food surplus and food waste. *Journal of Cleaner Production*, 76,106-115.

Papargyropoulou, E., Wright, N., Lozano, R., Steinberger, J., Padfield, R., and Ujang, Z., 2016. Conceptual framework for the study of food waste generation and prevention in the hospitality sector. *Waste Management*, 49, 326-336.

Parfitt, J., Barthel, M., and Macnaughton, S., 2010. Food waste within food supply chains: quantification and potential for change to 2050. *Philosophical Transactions Royal Society B*, 365, 3065-3081.

Parizeau, K., Massow, M.V., and Martin, R. 2015. Household-level dynamics of food waste production and related beliefs, attitudes, and behaviours in Guelph, Ontario. *Waste Management*, 35, 207-217.

Pereira-Moliner, J., Claver-Cortes, E., Molina-Azorin, J.F., and Tari, J.J., 2012. Quality management, environmental management and firm performance: direct and mediating effects in the hotel industry. *Journal of Cleaner Production,* 37, 82-92.

Pinto, R.S., dos Santos Pinto, R.M., Melo, F.F.S., Campos, S.S., and dos Santos Cordovil, C.M., 2018. A simple awareness campaign to promote food waste reduction in a University canteen. *Waste Management,* 28-38.

Pirani, S.I., and Arafat, H.A., 2014. Solid waste management in the hospitality industry: a review. *Journal of Environmental Management*, 146, 320-336.

Pirani, S.I., and Arafat, H.A., 2016. Reduction of food waste generation in the hospitality industry. *Journal of Cleaner Production*, 132, 129-145.

Pit Stop Community Café, 2018. *About us.* Available from: https://www.pitstopcafekl.com/ (Accessed 24 August 2018).

Pongrácz, E., and Pohjola, V. J., 2004. Re-defining waste, the concept of ownership and the role of waste management. *Resources, Conservation and Recycling*, 40, 141-153.

Principato, L., Pratesi, C.A., and Secondi, L., 2018. Towards Zero Waste: an Exploratory Study on Restaurant managers. *International Journal of Hospitality Management,* 74, 130-137.

Radwan, H.R.I., Jones, E., and Minoli, D., 2010. Managing solid waste in small hotels. *Journal of Sustainable Tourism,* 18(2), 175-190.

Radwan, H.R.I., Jones, E., and Minoli, D., 2012. Solid waste management in small hotels: a comparison of green and non-green small hotels in Wales. *Journal of Sustainable Tourism,* 20(4), 533-550.

Russell, S.V., Young, C.W., Unsworth, K.L. and Robinson, C., 2017. Bringing habits and emotions into food waste behaviour. *Resources, Conservation and Recycling*, 125, 107-114.

Saito, O., 2007. Resource use and waste generation by the tourism industry on the big island of Hawaii. *Journal of Industrial Ecology*, 17(4), 578-589.

Sakaguchi, L., Pak, N., and Potts, M.D., 2018. Tackling the issue of food waste in restaurants: Options for measurement method, reduction and behavioral change. *Journal of Cleaner Production*, 180, 430-436.

Save Food Initiative, 2017. *Save food congress as part of the interpack 2017*: Messe Düsseldorf and FAO sign prolongation of their cooperation. Save Food Initiative, Düsseldorf. Available from: https://www.save-food.org/cgi-bin/md_interpack/lib/pub/tt.cgi/SAVE_FOOD_Congress_as_part_of_interpack_2017_Messe_D%C3%BCsseldorf_and_FAO_sign_Prolongation_of_their_Cooperation.html?oid=62976&lang=2&ticket=g_u_e_s_t (Accessed 5 August 2017).

Sealey, K.S., and Smith, J., 2014. Recycling for small island tourism developments: food waste composting at Sandals Emerald Bay, Exuma. *Resources, Conservation and Recycling*, 92, 25-37.

Sebbani, M., and Costa, S., 2018. Food leftovers in workplace cafeterias: An exploratory analysis of stated behavior and actual behaviour. *Resources, Conservation and Recycling*, 136, 88-94.

Silvennoinen, K., Heikkila, L., Katajajuuri, J-M., and Reinikainen, A., 2015. Food waste volume and origin: Case studies in the Finnish food service sector. *Waste Management,* 46, 140-145.

Singh, N., Cranage, D., and Lee, S., 2014. Green strategies for hotels: estimation of recycling benefits. *International Journal of Hospitality Management,* 43, 13-22.

Sirieix, L., Lala, J., and Kocmanova, J., 2017. Understanding the antecedents of consumers' attitudes towards doggy bags in restaurants: Concern about food waste, culture, norms and emotions. *Journal of Retailing and Consumer Services*, 34, 153-158.

Solnet, D., 2012. Service Management in Hospitality Education: Review and Reflection. *Journal of Hospitality Marketing and Management,* 21(2), 184-214.

Steen, H., Malefors, C., Roos, E., and Eriksson, M., 2018. Identification and modelling of risk factors for food waste generation in school and pre-school catering units. *Waste Management,* 77, 172-184.

Stockli, S., Dorn, M., and Liechti, S., 2018. Normative prompts reduce consumer food waste in restaurants. *Waste Management,* 77, 532-536.

Styles, D., Schoenberger, H., and Galvez-Martos, J.L., 2015. Water management in the European hospitality sector: Best practice, performance benchmarks and improvement potential. *Tourism Management*, 46, 187-202.

Sustainable Restaurant Association (SRA), 2010. *Too good to waste: restaurant food waste survey report.* SRA, London.

Tatàno, F., Caramiello, C., Paolini, T. and Tripolone, L., 2017. Generation and collection of restaurant waste: characterization and evaluation at a case study in Italy. *Waste Management*, 61, 423-442.

ThaiHarvestSOS, 2018. *A food rescue foundation.* Available from: http://www.thaiharvestsos.org/home/ (Accessed 24 August 2018).

Thyberg, K.L., and Tonjes, D.J., 2016. Drivers of food waste and their implications for sustainable policy development. *Resource, Conservation and Recycling*, 106, 110-123.

Too Good To Go (TGTG), 2017. *How too good to go works for you*. Available from: http://toogoodtogo.co.uk/partners/ (Accessed 2 August 2017).

Think Eat Save, 2014. *About the Campaign. Think Eat Save*. Available from: http://thinkeatsave.org/index.php/about/about-the-campaign (Accessed 5 August 2017).

Thyberg, K.L. and Tonjes, D.J., 2016. Drivers of food waste and their implications for sustainable policy development. *Resources, Conservation and Recycling*, 106, 110-123.

Unilever Food Solutions, 2011. *World menu report global research findings 2011-sustainable kitchens: reducing food waste*. Unilever Food Solutions, London.

Unilever Food Solutions, 2017. *Food waste reduction*. Unilever Food Solutions, Surrey. Available from: https://www.unileverfoodsolutions.co.uk/chef-inspiration/from-chefs-for-chefs/food-waste-reduction.html (Accessed 3 August 2017).

United Against Waste e.V., 2017. *The association - what does united against waste e.V. concretely against waste.* United Against Waste e.V, Germany. Available from: http://www.united-against-waste.de/der-verein/was-wir-tun (Accessed 2 August 2017).

Victorino, L., Verman, R., Plaschka, G., and Dev, C., 2005. Service innovation and customer choices in the hospitality industry. *Managing Service Quality: An International Journal*, 15(6), 555-576.

Wang, L., Liu, G., Liu, X., Gao, J., Zhou, B., Gao, S., and Cheng, S., 2017. The weight of unfinished plate: a survey based characterization of restaurant food waste in Chinese cities. *Waste Management*, 66, 3-12.

Wang, L., Xue, L., Li, Y., Liu, X., Cheng, S., and Liu, G., 2018. Horeca food waste and its ecological footprint in Lhasa, Tibet, China. *Resources, Conservation and Recycling*, 136, 1-8.

Wansink, B., and van Ittersum, K., 2013. Portion size me: Plate-size induced consumption norms and win-win solutions for reducing food intake and waste. *Journal of Experimental Psychology: Applied, 19*(4), 320-332.

Waste and Resources Action Programme (WRAP), 2011. The composition of waste disposed of by the UK hospitality industry. WRAP. RES093-001, Oxon.

WRAP, 2013. *Overview of waste in the UK hospitality and food service sector*. WRAP. HFS001-006, Oxon.

WRAP, 2014. *Large buffet savings at Crieff Hydro*. WRAP, Oxon.

WRAP, 2017a. *The hospitality and food service agreement: taking action on waste*. WRAP, Oxon.

WRAP, 2017b. *Why take action: legal/policy case*. WRAP, Oxon. Available from: http://www.wrap.org.uk/content/why-take-action-legalpolicy-case (Accessed 5 August 2017).

WRAP, 2017c. T*aking action on waste information sheet: restaurants*. WRAP, Oxon. Available from: http://www.wrap.org.uk/sites/files/wrap/Restaurants.pdf (Accessed 23 August 2017).

WRAP, 2017d. *Surplus food redistribution case studies*. WRAP, Oxon. Available from: http://www.wrap.org.uk/content/surplus-food-redistribution-case-studies (Accessed 23 August 2017).

Wen, Z., Hu, S., De Clercq, D., Beck, M.B., Zhang, H., Zhang, H., Fei, F., and Liu, J., 2018. Design, implementation, and evaluation of an Internet of Things (IoT) network system for restaurant food waste management. *Waste Management*, 73, 26-38.

Williams, P.T., 1995. *Waste treatment and disposal*. Wiley, Chichester.

Williams, P., and Walton, K., 2011. Plate waste in hospitals and strategies for change. *E-SPEN, the European e-Journal of Clinical Nutrition and Metabolism*, 6, e235-e241.

World Resource Institute (WRI), 2013. *Reducing food loss and food waste: instalment 2 of creating a sustainable food future-working paper*. WRI, Washington.

Young, L.R., and Nestle, M., 2002. The contribution of expanding portion sizes to the US obesity epidemic. *American Journal of Public Health*, 92(2), 246- 249.

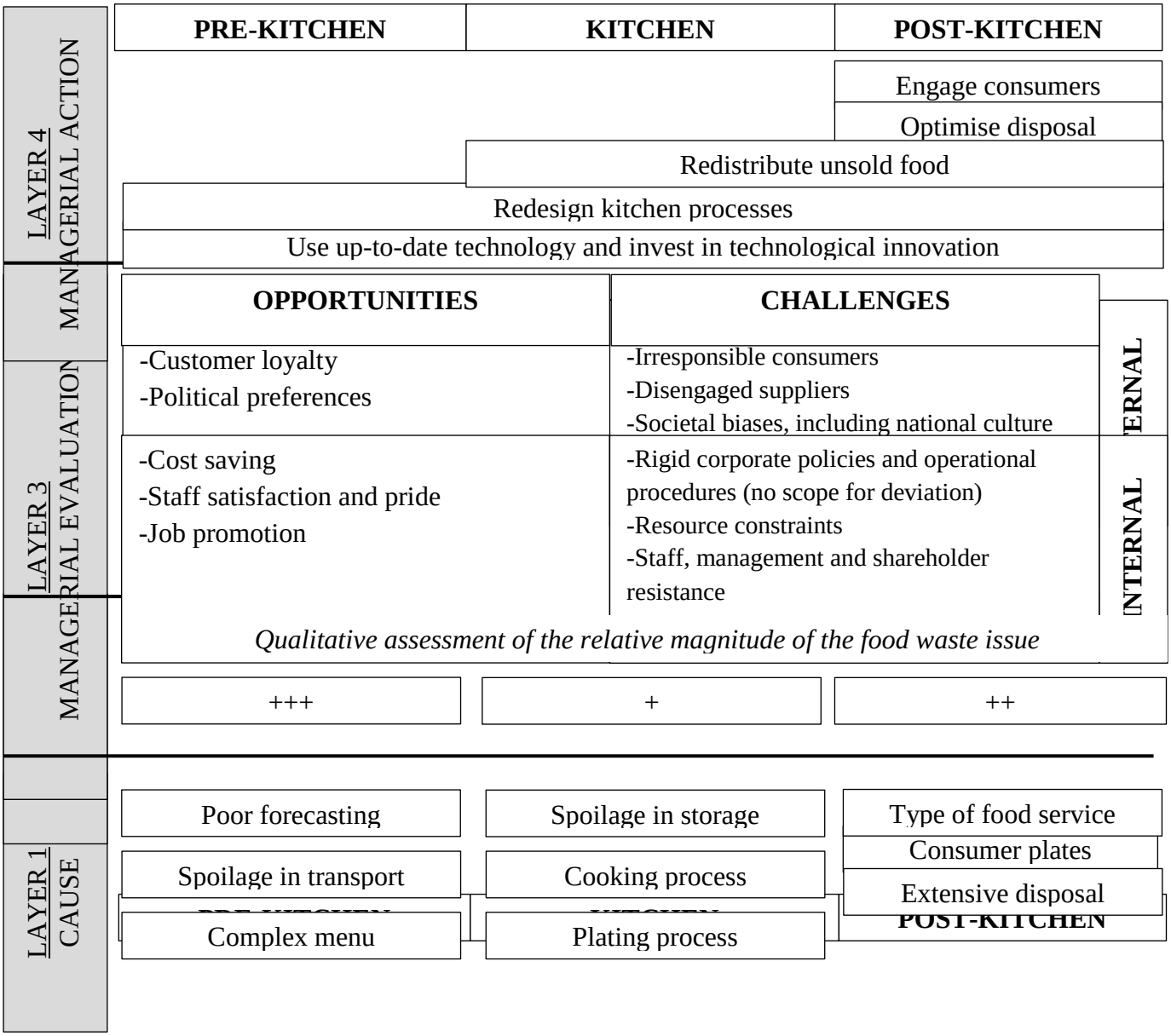

Figure 1. The framework of critical evaluation of the inter-linkages between the causes, effects, opportunities & challenges and managerial actions in hospitality food waste mitigation as derived from the literature review

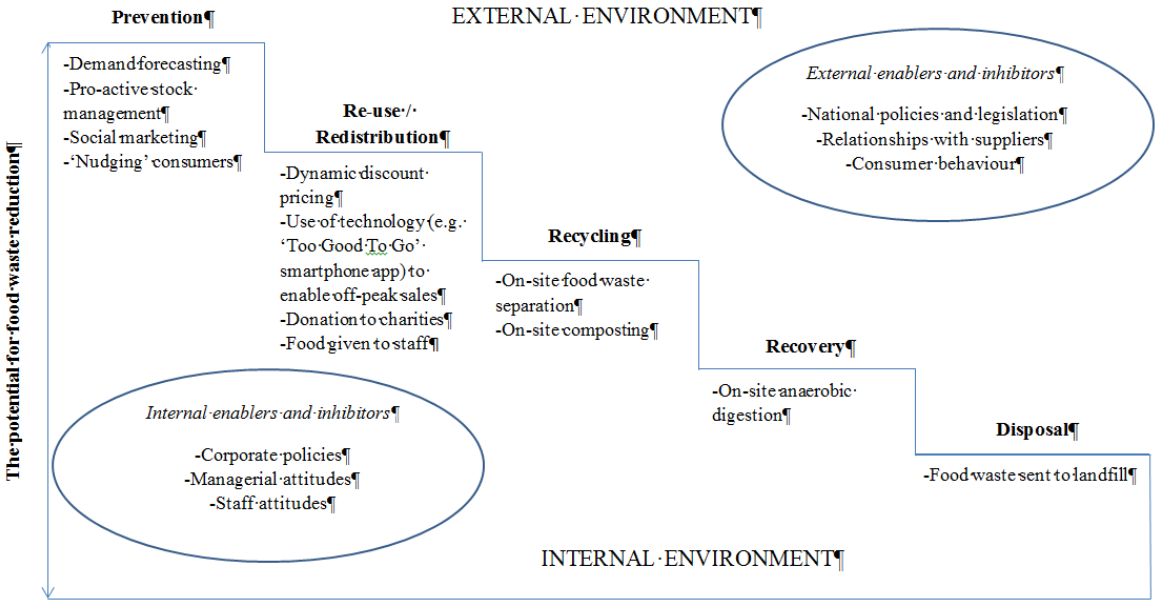

Figure 2. Hospitality food waste transformation framework with examples of activities that can be undertaken by hospitality managers to minimise food waste occurrence

Operational stage	**Pre-kitchen (pre-consumption)**				**Kitchen**				**Post-kitchen (consumption)**	
Operational area	*Demand forecasting*	*Procurement*	*Stock management*	*Menu design*	*Storage*	*Preparation*	*Plating*	*Serving*	*Sale / Customer service*	*After sale / After service*
Operational measures to reduce food waste	Maintaining continuous 'cold chain' - input from all stakeholders required									
	Regular food waste monitoring - input from all stakeholders required									
	Evidence-based forecasts	Short and responsive food supply chain	Demand-driven stock forecasting	Analysis of recipes	Contemporary technology and modern facilities	'Skilful' cooking	Portion control	Full plate service versus buffet service	Education and awareness-raising	Revenue maximisation for unsold food via use of technology (e.g. 'Too Good To Go' smartphone app)
	Use of (more advanced) demand forecasting models			Portion size planning						Food re-use / redistribution
				Use of seasonal ingredients						
				Re-use ingredients			'Skilful' plating			Food recycling
										Food recovery
Core in-house competencies required	Understanding of demand drivers	Knowledge of suppliers and negotiation skills	Regular stock inventory	Knowledge of menu engineering	Knowledge of kitchen equipment	Knowledge of cooking and food serving techniques		Understanding the implications of the adopted business model and addressing them pro-actively	Knowledge of consumer behaviour and principles of behavioural economics	Knowledge of appropriate (technological) solutions and how to access these
Training needs	Managerial and chef training		Chef training		Kitchen staff and chef training	Chef training		Managerial, chef, kitchen and waiting staff training	Waiting staff training	Managerial, chef, kitchen and waiting staff training
Estimated initial investment cost	High		Low	Medium		Low		Medium	Low	Low/Medium
Estimated potential financial savings	High				Medium	Low		Medium	High	

Figure 3. Managerial framework for hospitality food waste mitigation across all areas of hospitality business operations

Table 1. The evolution of food waste research in hospitality management. NB: 'Grey' literature, non-peer reviewed research and sources published in languages other than English are excluded. Research on healthcare/hospital food waste is excluded as its comprehensive review can be found in Williams and Walton (2011).

Year	Source	Geographical scope of analysis	Hospitality sub-sector	Type of study	Focus of Analysis 1= Quantification & characterization of food waste 2= Cause-effect of food waste 3= Managerial approaches to mitigation
2019	Filimonau *et al.*	UK	Food service	Empirical	1,2,3
2018	Chalak *et al.*	33 developed economies	Accommodation / Food service		1,2
	Juvan *et al.*	Slovenia	Food service		
	Wang *et al.*	China	Accommodation / Food service		
	Wen *et al.*		Food service		3
	Kuczman *et al.*	Brazil			
	Martin-Rios *et al.*	Switzerland			1,2,3
	Stockli *et al.*				2,3
	Lorenz *et al.*	Germany			

	Sebbane and Costa	France			
	Pinto *et al.*	Portugal			
	Principato *et al.*	Italy			1,2,3
	Sakaguchi *et al.*	USA			
	Derqui *et al.*	Spain			1
	Steen *et al.*	Sweden			
	Ericsson *et al.*				
2017	Ericsson *et al.*				
	Wang *et al.*	China			
	Tatàno *et al.*	Italy			
	Christ and Burritt	Global		Conceptual	
	Sirieix *et al.*	France and Czech Republic		Empirical	2,3
	Derqui and Fernandez	Spain			1,2,3
2016	Pirani and Arafat	UAE	Accommodation / Food service		
	Papargyropoulou *et al.*	Malaysia	Food service		
	Duursma *et al.*	The Netherlands			1,2
	Grandhi and Singh	Singapore			
	Heikkilä *et al.*	Finland			

2015	Silvennoinen *et al.*	Finland	Food service		
	Betz *et al.*	Switzerland			1,2,3
	Falasconi *et al.*	Italy			
	Charlebois *et al.*	Canada			
	Massow and McAdams				1
2014	Sealey and Smith	The Bahamas	Accommodation / Food service		
	Pirani and Arafat	Global		Conceptual	1,2,3
2013	Kallbekken and Saelen	Norway	Food service		
	Ferreira *et al.*	Portugal		Empirical	1
2012	Radwan *et al*.	UK	Accommodation		1,2,3
2011	Gössling *et al.*	Global	Food service	Conceptual	
2010	Radwan *et al*.	UK	Accommodation	Empirical	3
2008	Okazaki *et al.*	USA	Food service		1
2007	Saito		Accommodation / Food service		
2006	El-Mobaidh *et al.*	Egypt	Transport catering		

2004	Engstrom and Carlsson-Kanyama	Sweden	Food service		1,2,3
2003	Li *et al.*	Global	Transport catering		1
1997	Kantor *et al*.	USA	Food service	Conceptual	1,3
	Cummings	Global	Accommodation	Empirical	3
1992	Cummings			Conceptual	

15

16