Food Waste in Three-Star Hotels in Egypt: Quantification and Potential for Reduction

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Abstract

Food waste, by its very nature, is extremely inefficient. It represents a missed opportunity to mitigate environmental and economic impacts throughout the food supply chain. A few scholarly publications have focused on measuring and monitoring the volume of food waste generated in the Egyptian hotels, although this information is valuable for planning and for setting benchmarks to compare the performance of one hotel against another, or of one hotel through a timeframe. Therefore, this study took the quantitative approach to identify the quantity, source points and causes of food waste in three-star hotels in Egypt. Besides, the study aimed to examine the status of food waste prevention activities currently adopted by the investigated hotels. Data have been collected through the direct weighing method using the tracking sheet approach to get certain descriptive data from three-star hotels about the quantity, type, and origin of food waste. Additionally, semistructured interviews were conducted with hotels' executives to explore food waste prevention activities followed by the investigated hotels. The average food waste per hotel was estimated to be around (192.1) kg/day. The service/buffet stage had the biggest problem with food waste, which accounted for an estimated (48%) of all food waste produced in the investigated hotels. The majority (83%) of food waste at this stage was estimated to be avoidable food waste. These apparently high waste values were attributed to factors such as poor planning, types of food being served, facilities and technical constraints, eating behavior of customers, and lack of top management and employee support. Finally, intervention strategies were proposed based on the previous findings. **Keywords:** Food waste, waste mapping, quantification, three-star hotels, Egypt.

Introduction

Tourism is the third world's largest industry. Nowadays, the business volume generating by tourism industry parallels or even outperforms that of oil exports, food processing or autos. As disposable income continues to increase, the overall number of tourists is forecasted to grow by 4% per year between now and 2020 (WTO, 2016). Furthermore, in third-world countries with large population density, such as Egypt, this sector is one of the driving forces of the economy. Tourism is currently representing 11.3% of the country's GDP, 40% of Egypt's total non-commodity exports, and 19.3% of Egypt's foreign currency revenues (Egypt State Information Service, 2016).

The hotel sector is one of the main components of the tourism industry, and it has positive contributions to the national economy. Moreover, the future tourism development of a country also relies on the sustainable growth of this sector (Sandaruwani and Gnanapala, 2016). It is expected that this sector will see significant growth rates shortly in many countries of the world (Pirani and Arafat, 2016). However, this sector faces greater challenges than ever before. The sector is currently engaged in a long-term effort to develop a sustainable, efficient and competitive environment. As part of this environmental challenge, food waste management has emerged as a critical issue for the tourism industry in general and particularly the hotel sub-sector due to its harmful socioeconomic influences (Charlebois *et al.*, 2015). In Egypt, the issue has become more challenging as there are no clear systems for managing food waste, which inflicts serious environmental risks to the society and depletes a significant portion of the hotels' resources (Ibrahim and Mohamed, 2016).

On average, a hotel guest generates about 1kg of waste per night, more than half of it in food and organic wastes (International Hotel Environmental Initiative, IHEI, 2002). Indeed, some studies and initiatives have already targeted the amount of food waste produced globally (Betz *et al.*, 2015). Each year, the world loses or wastes around 30-50% of the edible parts of food that is produced and intended for human consumption (Gustavsson *et al.*, 2011; Drewitt, 2013). That is 1.3-1.5 billion tons 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 (UNEP, 2014). Such a high scale of food waste implies that food waste reduction should be a primary concern for the hotel sector as well as society. When hotels waste food, they are also wasting significant resources, energy, money spent on purchasing the food (Eshel *et al.*, 2014; Scholz *et al.*, 2015). In this sense, addressing food waste issue in the hotel sector could be seen as a "trigger

point" for reducing energy and water consumption onsite thus making the entire hotel operations more efficient and more competitive. Moreover, food waste is becoming a significant issue in the sustainability debate. Reducing food waste is broadly perceived as an essential prerequisite for the economic growth of the hotel sector since it can reduce hotels'GHG emissions and carbon footprint, as well as their entire water and ecological footprint (Drewitt, 2013; Sandaruwani and Gnanapala, 2016). Today, the hotel sector is not only responsible for producing safe and wholesome food, a role that has always been recognized, but also for demonstrating transparently how food waste has been managed through internal procedures to reduce waste quantities (Papargyropoulou *et al.*, 2014).

Research problem

Food waste has been widely studied from the perspectives of engineering, technology, with the exception of a minor yet increasing number of researchers from other disciplines (Cohen, 2006; Edwards and Mercer, 2007). Additionally, food waste has been extensively studied either through quantitative or qualitative methods (Beretta et al., 2013). The hotel sector is, undoubtedly, a remarkable source of food waste yet there is still an exceptional need for realistic statistics on food waste and avoidable food waste in this sector (Pirani and Arafat, 2016). While there are insignificant scholarly studies on food waste prevention in hotel sector generally, there are even fewer studies with a particular focus on small hotels. In Egypt, the results of a broad literature review on food waste management revealed that there had been no large-scale food waste studies encompassing the hotel sector (Abu Taleb, 2005; El Demerdash, 2016) using the weighing method. Though such studies were carried out elsewhere, e.g. in UK (Pocock et al., 2010; WRAP, 2011_a), Finland (Silvennoinen et al., 2015), Sweden (Karlsson, 2001; Engström and Carlsson-Kanyama, 2004; Eriksson et al., 2017), China (Wang et al., 2017) and the United Arab Emirates (Pirani and Arafat, 2016). Quantifying food waste would be important to provide a starting point from which effective strategies to promote efficient food use and eliminate food waste can be developed. Thus, such quantitative studies can encourage hotels to take serious steps towards the adoption of preventive strategies that reduce the overall volume of food waste in hotels.

Aims of the study

The purpose of this study is to fill part of the knowledge gap about food waste prevention in the hotel industry, with a particular focus on three-star hotels in Egypt. Specifically, the aims of this study are threefold. The first aim is to identify the quantity, source points and causes of food waste as it is generated at three significant stages of the food supply chain (i.e., storage, preparation, serving/displaying). The second aim is to explore food waste prevention practices implemented by the investigated hotels. The last aim is to suggest some intervention strategies to prevent or reduce food waste in three-star hotels in Egypt.

Literature Review

Food waste: A global perspective

Part of the complexity of the presented food waste issue is the difficulty in agreeing on a single definition for food waste. According to Chaboud and Daviron (2017), current definitions at the broadest levels defining the time and scope of food waste are in agreement. That is, the time definition for food wastage in the food supply chain occurs from the moment crops become ready for harvest, or just after harvest. Regarding scope, food waste only encompasses edible parts of food that is produced and intended for human consumption (Papargyropoulou et al., 2014). The definition of food waste, however, diverges under three broad definitions. Firstly, the Food and Agriculture Organization (FAO) defined food waste as food which was initially delivered for human utilization but was not consumed by humans. Instead, it was considered inedible (for humans) and diverted either as an animal feed or waste disposal (FAO, 2011). Secondly, Stuart (2009) added to the FAO's definition, by identifying that food waste ought to incorporate consumable material that is purposefully bolstered to animals or is a by-product of sustenance handling redirected away from the human food chain. Finally, Smil (2004) stated that food waste covers the definitions above. However, it also incorporates overnutrition, the gap between the imperativeness estimation of devoured food per capita and the essentialness estimation of food needed per capita. It is worth noting that the current study has concentrated on food and raw materials that were at some stages intended for human consumption. Other biological wastes, such as peelings or bones have not been measured.

Food waste can happen at any stage of the food supply chain (Grolleaud, 2002; Gustavsson *et al.*, 2011). At the final stages of the supply chain such as during retail and final consumption, the term food waste is applied and generally relates closer to behavioral issues (Parfitt *et al.*, 2010). Food losses, on the other hand, are "*the unintended result of an agricultural process or technical limitation in storage, infrastructure, packaging, or marketing*" (Lipinski *et al.*, 2013). Based on Quested *et al.* (2011) and Papargyropoulou *et al.* (2014), food waste can be classified into three categories: avoidable, unavoidable, and partially avoidable food waste. Avoidable food waste includes food that was at some stage intended for human consumption before being discarded as waste, despite the fact much of it would still be edible at the disposal point. Unavoidable food waste is a category referring to the fraction of the food that is not considered edible, such as vegetable peelings, eggshells, bones, and was never intended for human consumption. Partially avoidable food waste that is seen as unavoidable by some but not by others, such as bread crusts (Drewitt, 2013).

At the global level, many studies have sought to estimate the amount of food waste produced across the different stages of the supply chain, both in developed and developing countries. Such studies argued that the extent of food waste is significant in both the developed and the less developed countries. Food waste makes up a high percentage of total municipal solid waste ranging between 25% and 70% for most countries (Pipatti *et al.*, 2006). FAO results, presented in Table (1), show that per capita food waste in Europe and North-America is between 280-300 kg/year, stemming from a total of 900 kg/year of per capita of food originally intended for human consumption. North Africa and West/Central Asia produce 335 kg/year of food per capita for human consumption and 220 kg/year of it is lost. Sub-Sahara Africa and South/Southeast Asia produce 460 kg/year of

food per capita for human consumption and 120-170 kg/year of it is lost. Although the regions are similar in waste percentage, roughly one-third, the magnitude of food waste per capita is markedly different. The waste occurring at the consumer stage in developed countries is 95-110kg/year/capita, while in Sub-Sahara Africa and South/Southeast Asia it is notably lower at only 6-11 kg/year/capita. In other words, the total food waste at the consumer level in developed countries (222 million tons) is roughly equal to the total net food production in Sub-Sahara Africa (230 million tons) (UNEP, 2014). It is estimated that the global food waste generation is going to increase by 44% between 2005 and 2025 (Thi *et al.*, 2015).

Table 1.1 ood waste by world region						
World region	Production	Total per	Total per capita food waste source			
	volumes	capita	Foodservice		Consumer level	
	(million	food waste	levels			
	tons)	(Kg/yr.)	(Kg/yr.)	Percent	(Kg/yr.)	Percent
Europe	1100	280	190	68	90	32
North America	880	300	190	63	110	37
Industrialized Asia	1530	240	168	70	72	30
Sub-Saharan Africa	490	170	165	97	5	3
North Africa, West/	335	220	190	86	30	14
Central Asia						
South & Southeast Asia	1380	120	115	96	5	4
Latin America	805	230	200	87	30	13

Table 1: Food waste by world region

Source: (Killeen, 2015).

It is apparent that food waste makes up the largest percentage of municipal solid waste in both developing and developed countries (Pham et al., 2014). Food waste is usually high in developed countries at the consumption stage (Gustavsson et al., 2011). For example, annual statistics estimate that hotels in the UK produce 289,700 tons of waste per year, including 79,000 tons of food waste; 9% of total food waste is generated through the hospitality and foodservice sector in the UK (International Tourism Partnership, 2014). Statistics are comparative in other countries. For instance, Kranert et al. (2012) estimated the volume of food waste in Germany along the entire food supply chain (excluding the agricultural phase). He recognized that food waste in the food service industry is the second most noteworthy wellspring of food wastage and involve around 17% of the aggregate wastage (Betz et al., 2015). A Swiss study demonstrated that the food service industry ranked third as the largest source of food waste (18%) after households and the food processing industry (Beretta et al., 2013). On the other hand, in the United States, about 31%-40% of post-harvest food supplies are lost or wasted, much of which occurs at the consumption level (Neff et al., 2015). In the same context in the United States, 68 million tons of food waste is generated each year, with about 39.7 million tons going to the landfills. One-third of this waste is sourced from full and fast service restaurants (International Tourism Partnership, 2014). On the other hand, when comparing these values with those in the least developed countries, studies indicate that about 40% of the food waste occurs on the final consumption level (Grandhi and Singh, 2015).

For the case of Egypt, the absence of quantitative measurement methods and the general lack of waste management systems have led to significant inconsistency between published figures in online news and blog articles and official statistics about to the amounts of waste generated yearly. According to the estimates of the Egyptian Environmental Affairs Agency (EEAA), the volume of waste generated annually in Egypt is equal to 0.3 to 0.8 kg/day/capita, with an annual growth of 3.4%. However, the problem

is exacerbated in Greater Cairo due to high population density as well as the absence of regular waste management systems (Ibrahim and Mohamed, 2016).

Waste mapping

Waste mapping is a relatively new strategy that is being progressively used by organizations to facilitate effective waste management. Waste mapping is becoming increasingly popular strategy around the world, from places such as India (Green Yatra, 2014) to South Australia (Blue Environment Pty Ltd and Tonkin Consulting, 2012) and Finland (Paivarinta *et al.*, 2004). It enables the businesses to identify the sources and causes of waste occurrences and the resultant costs associated with these wastes (WRAP, 2012 _a, _b). This strategy in the hotel sector enables the property to monitor waste generation related to the type of waste generated in terms of the amount, location, i.e., receiving, storage, dining area, open air, dishwashing, etc. Subsequently, the property can manage its waste more efficiently (Pirani and Arafat, 2016). Figure (1) shows an example of a typical waste map for part of hotel operations.



Figure 1: A sample waste map for a typical hotel

Source: Based on (Owen et al., 2013).

The colored boxes indicate the forms of waste generated at different locations within the hotel, as shown in the map key. Thus, hotel management can focus on the sites/locations that produce the greatest amount of waste to be addressed in the hotel's preventive strategy to reduce the volume of waste sent to the landfill. The waste mapping inputs incorporate all the products and goods that entering the hotel system at this particular location in the hotel. Thus, data include detailed acquaintance about the purchasing methods, quantities ordered, the frequency of delivery, and costs (Owen *et al.*, 2013). On the other side, the outputs indicate the factors behind waste generation at that particular location. The hotel should inspect garbage and recycling bins, segregate the waste into subgroups, and record the weights of each group. By benchmark (compare) the costs of inputs to costs of outputs (including labor costs, energy, and time), the stream of resources can be fathomed, and any shrouded costs related to the waste can be distinguished and figured. This would make conceivable the identification of methodologies which might be implemented to

accomplish both monetary and environmental advantages. Once these advantages have been evaluated, they might be arranged in order of priority and afterward coordinated into the hotel's future waste management strategy likewise. Waste mapping opens the doors for cooperation between different departments of the hotel which generate comparative waste (Pirani and Arafat, 2016).

Quantification and source-points of food waste in the hotel sector

Substantially, hotels are engaging in the generation of a significant block of food waste along the entire food supply chain. Various studies have revealed some insights into the common waste types generated at hotels. For example, aluminum, plastic, glass, steel, cardboard, and food waste were referred as being the fundamental components of hotel waste (Pirani and Arafat, 2016). As stated in another study carried out by (Zein *et al.*, 2008), the common waste types generated at a typical hotel are shown in Table (2).

Waste Type	Components	Source		
Residential	Food/kitchen waste, used or dirty paper and	Typical facilities and		
wastes	wrapping, plastic wrapping or bags,	locations in the hotel		
	composite wrappers			
Food waste	Food waste and organic materials (Leaves,	Food and beverage outlets,		
	peelings, scraps, spoiled food, grass clippings)	kitchens		
Cardboard	Packaging materials	Typical facilities and		
		locations in the hotel		
Paper	Newspaper, office paper, packing materials,	Guestrooms, management		
	cardboard, brochures, menus, maps	offices, reception		
Plastic	Beverage containers, high-tech waste,	Food and beverage outlets,		
	packing materials	kitchens, Guestrooms,		
		management offices		
Metal Cans, high-tech materials, scrap materials,		Food and beverage outlets,		
	appliances, building materials	kitchens, Guestrooms,		
		management offices		
Glass	Windows, bottles	Food and beverage outlets,		
		kitchens, Guestrooms,		
		management offices		
Cloth	Linens, clothes, rags	Food and beverage outlets,		
		kitchens, Guestrooms,		
		management offices		
Wood	Furniture, building materials, pallets	Typical facilities and		
		locations in the hotel		

Table 2: Common waste types generated at a typical hotel

Source: (Zein et al., 2008; Pirani and Arafat, 2016).

Table (2) shows that multiple forms of waste can be generated at specific locations. The relative volume, the content and the frequency of each of these distinctive waste types are affected by many variables such as hotel type, guest attributes, guest and staff activities, and the various categories of restaurants available (Pirani and Arafat, 2016). Marthinsen *et al.* (2012) also argued that the hotel category plays a role in its waste generation; as it is assumed that there is a relationship between the quality of the food served and the waste generated. First class outlets can control food waste by serving smaller portions of high-quality food. For the typical hotel, waste can be classified into wet (organic/biodegradable)

and dry waste (Birani and Arafat, 2016). Wet wastes consist mainly of food waste (including food residues and restaurant leftovers), which can be more than 50 % of the hotel waste (Curry, 2012) and up to one-third of all the food served within the hotel sector (Marthinsen *et al.*, 2012). On the other hand, wet waste consists primarily of paper (25.3 %), cardboard (11.7 %), plastic (6.7 %), glass (5.6 %), and metal (4.5 %) (Alexander, 2002; Evans, 2008; WRAP, 2012 _{a,b}; Parfitt *et al.*, 2013).

These values show that the hotel sector produces an extensive volume of food waste contrasted with the other solid waste types (Sandaruwani and Gnanapala, 2016). Thus, an environmental waste management solution cannot be completed without some policies and action plans related to food waste. It is known that among all types of waste, food waste standout amongst the most critical materials to be diverted from landfills, as it degrades to produce methane, a potent gas of greenhouse gases which contributes fundamentally to environmental change (U.S. Environmental Protection Agency, 2016). Several studies have attempted to quantify food waste in hotels, which came mostly from the macro level to estimate the amount of food waste generated in national hotel sectors. These studies applied various methodologies to measure food waste, all of which have some downsides. Some approaches, such as waste characterization sorts, attempted to gauge the volume of food waste disposed in solid waste dumps (Thyberg, 2015). While other studies have relied on estimating the amount of food waste per meal served, which represents a crucial dimension for comparison: Andrini and Bauen's (2005) figure was 50 grams of food waste/ meal, though Baier and Reinhard (2007) evaluated 124g for each meal. In a Swedish study, food waste was found to range from 46 grams to 115 grams per meal (Engström and Carlsson-Kanyama, 2004). In a study on food waste among Jordanian students, a measure of 70 grams was recorded for each dinner (Al-Domi et al., 2011). Besides, in a study conducted in high schools in the UK over three weeks, students created 159-191 grams of waste per supper every day (Cordingley et al., 2011). Other studies have been conducted using different methods, such as examinations of statistics (Monier et al., 2010), waste compositional analyses (kitchen diary) (Schneider and Obersteiner, 2007; WRAP, 2008; Watanabe, 2009), material flow analysis (Drewitt, 2013), constructionist approach (Radwan et al., 2010), and food service management surveys and waste data statistics (Martinsen et al., 2012; WRAP, 2011_b).

These studies have not analyzed material flows within a hotel system to identify sourcepoints of food waste. When it comes to conducting material flow analysis, determining the food flows within the hotel system and points of food waste source (not just the amount of food waste) is extremely important. Waste prevention, by its very nature, means identifying the source and cause of food waste to prevent it from being produced (Scholz et al., 2015). Food within the hotel system passes through a number of processes that can be divided into two main phases: pre-consumption and post-consumption. Preconsumption includes all the processes that the food passes through before it reaches to the customer (i.e., in the kitchen), including food storage: pre-preparation, preparation, cooking and serving. On the other hand, post-consumption is all the processes that happen once the food reach to the customer, which logically includes consumption. Food waste sources in hotels can then be separated into pre-consumption and post-consumption food waste. Food waste before consumption is all food waste that occurs in the hands of employees and before the arrival of food with the consumer. For example, spoiled or out of date food, peelings and trimmings, inedible by-products, e.g., bones, coffee grounds, tea leaves, and kitchen error and overcooked food. On the other hand, post-consumption food waste is all waste that occurs as soon as the customer gets the food, which is the food left behind by the customer (Drewitt, 2013).

From the perspective of sustainability, there are many factors which influence how a specific property processes its waste and to what degree it actualizes recycling. These factors include the geographic location of the property, the kind of materials being recycled, and the accessibility of arranging/ recycling facilities in its region. Once actualized, the achievement of a recycling program relies upon factors such as the availability of buy-back centers, contractors' eagerness to participate in recycling programs, and efficient training programs (Shanklin and Hackes, 2001). Additionally, the appropriation of ecological practices by a hotel relies upon variables such as the hotel size, property age, company type, brand size, hotel association or affiliation, stakeholder environmental pressure, and other hotel characteristics (Alvarez Gil et al., 2001). For instance, the Radisson SAS hotels have announced a rate of 3.1 kg of non-refined waste/guest- night chain wide. This is extensively more noteworthy than the chain-wide average of Scandic Hotels, which detailed a rate of 0.515 kg of unsorted waste/guest-night (Bohdanowicz, 2006). Similarly, a study of 52 hotels in Ghana found that bigger properties with higher stars ratings were found to apply waste management methodologies to a more prominent level than smaller ones (Mensah, 2006).

Methodology

Based on the research objectives, an integrated methodology of both quantitative and qualitative approaches have been employed to collect the relevant information. To supplement the qualitative approach, data have been collected from related literature to give more insight concerning the topic being investigated. This study utilized multiple quantitative tools including semi-structured interviews and direct weighing method. Semi-structured interviews were conducted with hotels' executives to provide an insight into food waste prevention practices followed by the investigated hotels and the extent of their implementation on the ground. Moreover, data have been collected through on-site measurement using the tracking sheet approach to obtain certain descriptive data concerning the quantity, source points, and origin of food waste. Additionally, to identify the main factors that affect the food waste generation in the investigated hotels, waste mapping technique was applied. The methodological framework for the study is explained in Figure (2).



Figure 2: The methodological framework for the study

Population and sampling techniques

The population outline for this study incorporates (63) three-star hotels which located in Greater Cairo. This region was chosen as it represents more than one-quarter of the total number of the three-star hotels in Egypt. The names, addresses, and e-mails of the population have been acquired from the Egyptian Hotel Guide (36th edition, 2016) edited

by the Egyptian Federation of Tourist Chamber (EFTC). To get real approximate measures for the volume of food waste generated within the three-star hotel sector in Egypt, it was necessary to include as large number of randomly chosen hotels as possible. However, due to the nature of the study, only (32) hotels expressed their readiness to cooperate with the process that can cause some inconvenience to run.

Semi-structured interviews

Semi-structured interviews with hotels' executives were conducted at an initial stage of the study to survey the general characteristics of the hotels and to help the researcher to get a closer look into the food and beverage operations of, and waste management practices for, the whole set of the investigated hotels. It is worth mentioning that about 56% (i.e., 18) interviews were conducted with the executive chefs. More than one-quarter (31%) of the interviewees were food and beverage managers and approximately (13%) of managers with responsibility for quality assurance were involved in the interviews. Later, these interviews led to a number of site visits to the storerooms, kitchens and waste rooms to plan the on-site measurements and to map the material flow. In most cases, interviews were not audio recorded to make interviewees feel more comfortable. Besides interviews, whenever necessary the data has also been collected from the hotels' documents and reports.

Quantification of food waste flows

The quantification of food waste was achieved through the physical measurement of food waste generated in the investigated hotels to quantify the volume of *avoidable food waste*. Wastage can be generated at any stage of the food supply chain. However, the present study, in accordance with Engström and Carlsson-Kanyama (2004), is limited only to food that is wasted at three significant stages of the food supply chain. This includes storage waste: food waste due to improper storage conditions; preparation waste: food waste occurring during food preparation and cooking; and serving waste: food waste remaining from the buffet and leftover left on consumers' plates. To determine the minimum number of days required to measure the amounts of food waste generated in the investigated hotels, the following equation was applied:

$n^{\circ} = (t \cdot S/e \cdot X)^2$

Where n is the minimum number of days, t is the degree of freedom and the level of confidence, S is the standard deviation, X is the value of the arithmetic mean, and e is the acceptable error level at 5% (Gallardo et al., 2016). The t value varied from one hotel to another because it is associated with the length of the observation stage, giving the number of sample points or the degree of freedom. The degree of freedom equals the number of observed days minus one, n -1 (Gallardo et al., 2016; Abdelaal, 2017). As no information was available at the beginning of the observation period about the mean and standard deviation, they were calculated at the end of each day, and these ratings were used to find n° . If n° was less than the number of days already observed, the observation was extended for another day. This process was repeated until the minimum required number of monitoring days was achieved. A total of 110 observing days were spent on the measurement period which started in May 2017. On average, the investigated hotels were each visited on several monitoring days for a total of between three and four days to verify the potential daily differences of food waste. Every day, the amounts of food waste being produced were physically measured to determine whether they contained avoidable or unavoidable waste. During the physical observations, the researcher focused on sorting food waste properly and that the waste bags that were weighed consisted only of food and no other materials. The measurement included kitchen waste resulted from both storage

and preparation areas and food waste generated at the service/displaying stage. To weight the food leftovers at the service stage, the researcher got permission to arrange a sorting area close to dish return area, where the researcher separated food waste and, when necessary, the restaurant staff helped to sort out the waste. To easily monitor and track food waste in the investigated hotels, a tracking sheet was specially designed for this purpose (Table 4). Total volumes of food waste generated at the different areas were calculated and inserted into the tracking sheet at the end of each observation day.

Day	Date	Storage Area		Main Kitchen			Foodservice/displaying			
		#	Weight (kg)		#	Weight (kg)		#	Weight (kg)	
		containers filled	Avo.	Unav.	containers filled	Avo.	Unav.	containers filled	Avo.	Unav.
1										
2										
3										
4										
Container										
Volui	me									
Total										
volun	ne*									
Base data Total # of customers served										

Table 4: Food waste tracking sheet

*Total volume = container volume x number of container fills Source: Modified from WRAP, 2012a.

Statistical analysis

The amounts of food waste from different hotels were classified based on the type of food waste (avoidable/unavoidable) and recorded on the tracking sheet. Data were initially analyzed using descriptive statistics, crosstabs, and histograms to find out the average generation of food waste during the 110 observation days. The results were used to estimate the annual food waste generation. ANOVA was used to measure the effect of day of the week on the produced food waste.

Results

Characteristics of the surveyed hotels: Results of the interviews

Several questions were included in the interviews to determine the characteristics of the investigated hotels. An attempt has been made to characterize the hotels according to their types and sizes. The interviewees were asked to categorize their hotels according to their type of affiliations, the number of available guestrooms, the number of food and beverage outlets, and the number of employees on food handling related functions. Based on information from both the interviews and the Egyptian Hotel Guide (36th edition, 2016), these hotels had different characteristics in the terms of ownership, size, and the number of food and beverage outlets. For example, most of the hotels were private-owned establishments (97%); (47%) of the investigated hotels belonged to chains affiliation, while (53%) were independent. The hotels were of varying sizes. In terms of numbers of rooms, (81%) had less than (200) rooms/hotel while (19%) had more than (200) rooms/hotel and in total. The investigated hotels had (85) food and beverage outlets including fine dining, casual dining, quick service, and cafes. These outlets serve international standardized menu items as well as the locally adapted items. Finally, the interview covered the total number of hotels personnel on food handling related functions and their employment status (full-time, part-time, and casual). The interviews reported a noticeable variance between the investigated hotels in such point. This variation is related to the fact that these hotels differ significantly in their sizes and levels of food and beverage service rendered. The lower limit of such number was (45) persons, while the upper limit was reported to be (210) persons. The calculated arithmetic mean was (67) persons. For all hotels, food mostly passes through four main stages: (1) storage, (2) preparation/cooking, (3) service and (4) consumption. Storage involves the process of keeping food temporarily in different stores (cold/dry) until it is ready to progress into the next steps. Preparation and cooking in kitchens involve the assembling of pre-prepared ingredients and reheating, cooking ingredients or meals. Serving includes both table service and assisted self-service. The final stage is when customers consume the food in the service areas.

Status of food waste prevention practices

One of the important issues in preventing food wastage is to have a comprehensive system to prevent or minimize food waste throughout the hotel. Waste prevention includes activities and practices that avoid waste generation from the source and ensure reduction of surplus food, while waste management includes different practices of dealing with food waste once it is generated in the various stages that the food passes through from the time of receiving until it is presented to the customer for consumption. Figure (3) highlights the activities that the hotels are engaged in to demonstrate their commitment and support to prevent/reduce food waste in their premises.



Figure 3: Activities implemented by the interviewed hotels to prevent food waste

The vast majority of the interviewed hotels claimed that they have a number of documented statements that provide the essential control needed to address food waste. When the interviewees asked to outline the key points contained in their statements, (34%) specifically mentioned improving food waste management practices while (19%) mentioned staff training. Internal hotel courses on food waste management (in-house demos, lectures, and workshops), meetings and briefings, and posters and signage were the primary methods by which food handlers were made aware of food waste practices. However, it was notable from interviews that there is a significant proportion of the interviewed hotels did not assign a specified manager to oversee the waste management practices, and this might be the reason for the apparent increase in the response rate from those in the executive chef category.

Moreover, the results indicated that most of the interviewed hotels did not have documented data on the amount of organic waste they are generating, and specifically they did not have any figures representing the amount of food waste generated from their operations. In addition, (65%) of the hotels interviewed were sending their organic waste to the dumps as the primary method of disposing of daily food waste. They just place the waste in black plastic bags and then transfer the waste to the landfills by the contracted waste carrier (from either the local governmental authority or private formal/informal sector). Furthermore, many hotels do not participate in prevention strategies to separate organic waste from other solid wastes. More than a quarter of the interviewed hotels (33%) had signs in the food preparation areas to motivate staff to reduce waste of food, though none of the hotels had such indications in the restaurants/guestrooms. Figure (3) shows that approximately (28%) of the hotels that participated in the interview donate food to charitable organizations such as the Egyptian Food Bank. It is worth mentioning that none of the respondents have current or future plans for waste recycling. During the interviews, hotels' executives were asked to identify the possible reasons for food waste in their establishments. Figure (4) shows interviewees ' responses to the main reasons for disposing of food. The main causes were as follows: actual versus forecasted number of customers (56%), types of food being served (53%), facilities and technical constraints (50%), eating behavior of the customers (44%), poor measuring/recording of flows and waste generation (35%), and lack of top management and employee support (25%).



The responses discussed thus far were tested for statistical correlation to four independent hotel attributes (ownership affiliation, number of available guestrooms, number of available food and beverage outlets, and number of employees on food handling related functions). The p-values resulting from the correlation tests are shown in Table (5).

		Hotel Attributes					
	n Valuas	Ownership	No. of	No. of	No. of		
	<i>p</i> -values	affiliation	available	F&B	employees		
			guestrooms	outlets			
	Having a food waste reduction plan	0.192	0.001	0.165	1		
Responses	Educate and train staff	1	0.524	1	0.165		
	General awareness campaigns	0.572	1	0.748	0.001		
	Routines for leftover for internal use	0.887	1	0.245	0.266		
	Sending food waste to the dumps	1	0.772	0.559	0.558		
	Separating organic waste from others		0.585	0.565	0.221		
	Donate surplus food	0.001					

Table 5: Correlation between independent hotel attributes and the interview responses

(Significance value = 0.05)

Data in Table (5) show that there is a significant correlation between the size of the hotels (in terms of the number of available guestrooms) and the existence of a clear plan to

reduce food waste with specific objectives and procedures. This result indicates that the larger the hotel, the higher the percentage of interviewees who said they had a food waste reduction plan. Indeed, another significant correlation was that between the number of employees in food handling related functions and the organization of general awareness campaigns in the interviewed hotels. Finally, a significant correlation was found between the type of the hotel's affiliation and whether or not it donated surplus food to charitable organizations such as the Egyptian Food Bank. It was found that hotels which were part of an affiliated chain or were joint venture owned hotels were more willing to donate surplus food to charitable organizations.

On-site measurements

As described in the methods section, food waste was divided into storage waste, production waste, and buffet/service leftover waste. Each of the three stages studied was found to have quite different food waste characteristics and varying amounts of food waste produced per customer. This information is provided in Table (6).

		noters/ duy		
Food material	Total FW	Avoidable FW	Unavoidable FW	FW
flow	(kg)	(kg)	(kg)	/customer* (g)
Storage Area	39.5	29.6	9.9	-
	± 12.5	(75%)	(25%)	
Production Area	60.9	12.3 ± 04.6	48.6 ± 11.1	92.7
	± 13.2	(20%)	(80%)	± 41.6
Buffet/Service	91.7	76.6 ± 18.6	15.1 ± 06.0	214.3
	± 20.8	(83%)	(17%)	± 71.2
Total	192.1	118.5	73.6	-
		(61.7%)	(38.3%)	

Table 6: The average and standard deviation of food waste generated in the observed hotels/day

* based on the number of customers served and average FW generation.

± indicates standard deviation

Total food waste per hotel was estimated to be around 192.1 kg per day. The extrapolation of these results to the length of the year equates to an annual disposal of approximately 70 tons of food waste. The food material flow identified the different food waste source points across the investigated hotels. An important feature of food waste generated in the studied hotels was the percentages of avoidable and unavoidable food waste. As mentioned earlier in the literature section, it is very imperative to distinguish between "unavoidable" and "unavoidable" food waste. This distinction is important in the process of formulating a sustainable strategy to address food waste. In addition, it provides insight into the extent to which food waste can be prevented or reduced. Thus, it is pivotal in the formulation of strategies to manage food waste, as proposed by (Papargyropoulou *et al.*, 2014). Data in Table (6) showed the amount and proportion of food waste generated at each different source points in the food supply chain in the studied hotels/day. Most food wastes occurred at the last stage in the food supply chain, which is the final consumption. The buffet and service areas generated the highest percentage of food waste, and the majority was completely avoidable in all the surveyed hotels (T = -4.365; p < 0.005).

As Table (6) and Figure (5) illustrate, (61.7%) of all food waste generated in the studied hotels was avoidable, which shows the limited scope for food waste prevention. The average food waste generated at the storage stage was (39.5) kg/day. The majority (75%) of food waste generated at this stage was estimated to be avoidable food waste. This

clearly indicates that particular attention should be directed to improve the conditions and technologies of the storerooms in the investigated hotels to prevent spoilage and to minimize food waste at the source. At the production stage, the majority (80%) of food waste was classified as unavoidable food waste, as it comprised of mainly trimmings like vegetable, fruits, meat trimming scraps, fats, bones, seafood shells, blood, etc. The fact that such little amount of food is wasted in production stage across all hotels is a testament to the proper food production systems. To adhere to the systems, all employees in the studied hotels are required to use the appropriate amount of foods according to the recognized menus and standard recipes. This can also be attributed to the fact that a large proportion of these hotels rely on the use of convenience food products instead of preparing food from scratch.



Figure 5: Estimates and sources of avoidable food waste at the observed hotels/day

The average food waste generated at the buffet/service areas was (91.7) kg/day. The service/buffet stage had the biggest problem with food waste, which accounted for an estimated (48%) of all food waste produced in the investigated hotels. The majority (83%) of food waste at this stage was estimated to be avoidable food waste. The large proportion of food waste in this stage can be an indication of the lack of customers' conscious of food waste. In addition, through on-site observations, it was evident that the local menu items were much larger than the international standardized menu items. It was also observed that customers left behind a large amount of food on their plates. The food waste from the customer dishes was a combination of inedible parts and edible surplus food. On the other hand, most of the food leftovers in the buffets were edible, with an avoidable portion of (94%). However, the average estimates and sorts of customer plate leftovers changed perceptibly from one outlet to another, depending on the outlet type. The average food waste of the customer plate leftovers were staples like potatoes, rice and pasta (30%), followed by salads, vegetables and fruits (25%). The waste of all kinds of main courses (including seafood, meat, poultry, and vegetarians) added up to (23%) of the total food waste generated. Cheeses and dairy products are among the least wasted food categories, accounting for 3% (Figure 6).



Figure 6: The average estimates and sorts of customer plate leftovers

To understand whether the amount of food waste varied from one day to another, one-way ANOVA was applied to the data collected from sampled hotels with a 95% confidence level (a = 0.05). ANOVA analysis resulted in F = 21.05 and p-value < 0.05, which suggest that at least on one day there is a difference in the average food waste generation. As a result, the factor day of the week affects generation rates in the investigated hotels.

Discussion

In this study, the issue of food waste in three-star hotels in Egypt was examined, including its average daily amount, common types, primary source points, causes and possible practices to prevent/reduce it. The interviews conducted with hotels' executives as part of the initial stage of this study helped to survey the general characteristics of the hotels and to get an insight into the food and beverage operations of, and waste management practices for, the whole set of the investigated hotels. The study found that a number of the interviewed hotels claimed having documented statements in place that provide the necessary control needed to address food waste. These statements were most commonly in the form of an informal commitment to food waste management practices. However, the results indicated that most of the interviewed hotels did not have documented data on the amount of organic waste they are generating, and specifically they did not have any figures representing the amount of food waste generated from their operations. In addition, (65%) of the hotels interviewed were sending their organic waste to the landfills as the primary method of disposing of daily food waste. They just place the waste in black plastic bags and then transfer the waste to the dumps by the contracted waste carrier (from either the local governmental authority or private formal/informal sector). Furthermore, many hotels do not participate in prevention strategies to separate organic waste from other solid wastes. Therefore, relatively speaking, the investigated hotels have demonstrated marginal achievements insofar as the waste management is concerned. Indeed, the actual adoption of food waste reduction practices in the investigated hotels is noticeably low as evidenced by the volume of food waste generated in these hotels, which will be discussed in the next section.

Due to the lack of reliable data on the volume of food waste generated daily in three-star hotels in Egypt, on-site measurement was an essential tool for estimating the size of the food waste problem. The on-site analysis phase not only allowed the quantification of the total quantity of food waste generated daily at the selected sites but also allowed the monitoring of the waste management practices and activities at those sites. Average daily food waste and food waste per customer served were two measures used to assess the intensity of food waste in the selected sites. Daily food waste was determined based on both avoidable and unavoidable food waste data. Food waste per customer served was based on avoidable food waste and the number of customers served at the observed locations. Despite the fact that the first technique gave adequately high rates that were practically identical food waste generated at food service establishments in Europe and North-America, the second measure, which relies on the number of customers served and average food waste generation, gives a more exact and alarming figure of the exact level of wastage.

Considering the total avoidable food waste generated and the number of customers served in the investigated hotels brought about (214.3) grams of food waste per customer served. These results are high compared with the findings in the report delivered by BIOIS and based on several estimates of food waste according to statistics from the Statistical Office of the European Communities (Eurostat) and those results for the EU15 were 74 g/day and for the EU12, 33 g/day (Monier et al., 2010). Whereas, the results are consistent with the results of the FAO report, which indicated that on average customers from Europe and North America generate 260-315 g/day of food waste (FAO, 2011). In a recent study conducted in China based on the direct weight method and the survey of 3557 tables in 195 restaurants in four cities, the average daily amount of food waste generation per customer in each four cities was 93 grams (Wang et al., 2017). On the other hand, total food waste per hotel was estimated to be around (192.1) kg/day. The extrapolation of these results to the length of the year equates to an annual disposal of approximately (70) tons of food waste which is less than recorded in international studies (Karlson 2001; Engström and Carlsson-Kanyama, 2004; WRAP, 2011_b). This is a logical result as the current study focuses only on three-star hotels than other hotel categories. However, when comparing cautiously, the percentage of avoidable food waste in this study (61.7%) was convergent with the fraction reported by WRAP ($2011_{\rm b}$), at about (67%) and the fraction reported by Betz et al. (2015) at about (79%) of the food waste.

Further analysis of the results based on the food waste source points showed that most of the food waste was generated in serving areas. The average food waste generated at the buffet/service areas was (91.7) kg/day. The majority (83%) of food waste at this stage was estimated to be avoidable food waste. In general, a la carte style of service generated less waste than the buffet style of service. In fact, these results are consistent with the findings of other international studies. These studies emphasized that the a la carte service helps to reduce plate waste (Hackes et al., 1997; Sarjahani et al., 2009, Lam, 2010; Ganapathy, 2013; Silvennoinen et al., 2015; Birani and Arafat, 2016). The food waste from the customer dishes was a combination of inedible parts and edible surplus food. On the other hand, most of the food leftovers in the buffets were edible, with an avoidable portion of (94%). However, the average estimates and sorts of customer plate leftovers changed perceptibly from one outlet to another, depending on the outlet type. The average food waste of the customer plate leftovers were staples like potatoes, rice, and pasta (30%), followed by salads, vegetables and fruits (25%). The waste of all kinds of main courses (including seafood, meat, poultry, and vegetarians) added up to (23%) of the total food waste generated. Cheeses and dairy products are among the least wasted food categories, accounting for (3%).

It can be concluded that factors such as actual versus the forecasted number of customers, types of food being served, facilities and technical constraints, eating behavior of customers, poor measuring/recording of flows and waste generation, and lack of top management and employee support are suggested to be the main reasons of food waste.

Inaccurate forecasting of food demand in hotels contributes significantly to increased food waste rates (Gu, 2014). Hotels are attempting in various ways to be as accurate as possible in their forecasts of the number of guests to be served to control food cost. However, reducing the amount of food required to meet and satisfy the demand of customers is a risk that most hotel establishments are not willing to afford, so they prefer to fail in favor of abundance side. The right balance, when deciding on the amount of food to be cooked daily in hotels, is not an easy task (Parfitt *et al.*, 2013). Estimating the right number of customers is only one side of the problem. The decision depends on other aspects such as information of previous guest patterns, the predictability of guest numbers, menu size, and external factors such as hotels/restaurants situated around the property. Foreseeing the right amount to be cooked can be done using electronic instruments. However, numerous culinary specialists like to depend on their own experience. Hotels can then focus more on fewer options and higher quality items. The storage of a wide range of menu items daily inevitably leads to food waste (European Commission, 2011; McKenzie *et al.*, 2011).

In the same vein, the significant volume of food waste may be attributed to the type of food being served. The investigated hotels have different food and beverage outlets including fine dining, casual dining, quick service, and cafes. These outlets serve international standardized menu items as well as the locally adapted items. Based on the findings of this study, one can conclude that the volume of food waste generated in the preparation and cooking areas of the studied hotels depends on the types of food being prepared. The rate of food waste increases in hotels that rely on fresh and raw ingredients. In spite of the fact that choosing what to cook is of importance in terms of developing food waste reduction strategies, it would not be feasible for a hotel, for instance, to confine itself to just certain dishes or cooking styles in its restaurants keeping in mind the end goal to limit food preparation waste (Parfitt *et al.*, 2013). Nonetheless, what a hotel can do is to distinguish those types of food/dishes which tend to produce less waste and endeavor to preferentially serve those items or feature them (through, for example, menu engineering), if economically practical (Birani and Arafat, 2016).

In addition, it was evident through the onsite observations that local menu items were much larger in size than the international standardized items. A study conducted by the WRAP, based on interviews with customers about their latest dining experiences, found that the main reason for why customers left food behind on their plates was that they thought the portion sizes were too big (WRAP, 2013). The large portion size of the local items may be expected to generate more waste than other dishes. Therefore, all items listed on the menus should have a controlled portion size to maintain food waste in check. Hotels can also work hard to understand the requirements of their customers. This may involve using menu engineering approach to identify the different items that the customer significantly leaves behind on his or her plate, and then reducing those foods (Drewitt, 2013). In an attempt to control the amount of waste left behind by customers, some food service operations around the world have resorted to provide incentives for customers to finish the food they ordered by charging them for the food they do not eat. For example, one of the Chinese restaurants in London, Kylin Buffet, charges customers \$ 32 as a fine 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 do not eat everything on their plate (Jefferson, 2012; Drewitt, 2013).

Food waste can also attribute to the eating behavior of the customers. In its study, the WRAP acknowledged that there is a distinction between individuals who eat out for the social experience and individuals who simply eat for refueling (WRAP, 2013). The individuals who eat in hotels and restaurants are likely to leave food on their plates from those who go elsewhere, such as fast food restaurants, where they seem more likely to eat

outside to refuel. The study also found that because meal leavers are more likely searching for the full dining experience, they will order more courses (appetizer, main course, 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.

One of the factors that significantly contributed to the generation of food waste in the investigated hotels is the limited measurement/recording of flows and waste generation. Several international studies have highlighted that among the important actions that hotels can take to reduce the volume of food waste is the proper and periodical recording of flows and waste generation (WRAP, 2013). The identification of quantities and sources of waste in hotels is one of the main pillars on which any waste management strategy is based.

Conclusion

This study attempted to fill a gap in the literature by estimating the generation of food waste in three-star hotels in Egypt through on-site measurements. Food waste not only costs resources but also negatively affects the whole environment. It is evident from the field study that three-star hotels in Egypt generate significant volumes of food waste compared to the volumes recorded in other countries in Europe, Asia and America. The very high rates of food waste generated in these hotels are mainly due to the operational processes of these hotels.

To curb such issues, the prevention of food waste should be the priority for the hotels in Egypt. The positive side of this issue is that there is room for these hotels to prevent or limit these volumes to reach to their food waste prevention targets. Prevention is essential to achieve the goals of reducing food waste and improving the effectiveness of using available resources. This can be accomplished through the application of some strategies that could have a substantial impact on food waste production and save hotels a significant amount of resources.

Recommendations and implications

Food waste can be reduced through careful planning, good management and documenting food waste data, which helps to identify the outlet's food waste sources and forms a basis for finding solutions. Further, hotels can adopt waste mapping approach to effectively manage food waste and thus achieve the ultimate goal of reducing food waste. This new approach helps hotels to answer the important questions of where and how food waste occurs across the different stages the food supply chain, and how much it costs them. Based on this information, waste locations can be controlled efficiently and economically.

In addition, it would be essential to take into consideration the amount of serving waste as that food could be redistributed quite easily if it could not be avoided. Thus, having a good estimation of the number of expected customers and careful menu planning could have a significant impact on preventing food waste.

There is also a real need for hotels to ensure that the back areas are clean and that clear labels should be marked on the waste containers or be color-coded for easy separation of different types of waste. In addition, according to the findings of this study, one of the main challenges of reducing food waste in the hotel sector in Egypt will be minimizing buffet/display service waste. Thus, it is suggested to change the style of service from buffet to a la carte menus and serving smaller portions of potatoes, rice, and pasta to control the food cost as well. Hotels should be encouraged to become more involved in donating the remaining food to charitable organizations, such as the Egyptian Food Bank, that can receive and handle such donations in a safe manner. Finally, it would also be interesting to understand the need to continuously invest in training and awareness programs for both

employees and customers to raise their awareness of the importance of reducing the waste of food.

Future Work

The field study showed that a considerable volume of food waste is generated by three-star hotels in Egypt. These data are important because they indicate the amount of food waste that can be reduced or diverted from the landfill stream. More research is necessary to evaluate the impacts and feasibility of food waste prevention and diversion programs in the hotel industry. It should also be noted here that due to the difficulty of collecting samples from all food outlets in the studied hotels and the time and financial constraints, sampling for food waste was often restricted to one or two food and beverage outlets. Moreover, working with staff at these outlets and attempting to change the existing system of separation and disposal processes was a major impediment to this study. However, future research should further investigate the overall properties of food wastes (i.e., chemical and physical) and provide a comprehensive evaluation of their potential treatment. Foodservice providers at universities, schools, hospitals, restaurants also constitute an opportunity to exploit food waste and should be considered for future research.

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