

## **The Effect of Food Operations Sustainability on Food Operations Efficiency: The Mediation Role of Food Waste Management in Five-Star Hotels in Greater Cairo**

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### **Abstract**

The aim of this research is to investigate the relationships among food operations sustainability, food waste management, and food operations efficiency. Therefore, the research methodology is analytical, the population of this research is the staff of five-star hotels in the greater Cairo area, and the sample is random stratified. As a result, the researcher obtained information from 564 participants from the food and beverage department. The data was analyzed by the researcher using structural equation modeling (SEM) with the SmartPLS 4.1.0.0 software. This research revealed a high positive correlation between food waste management (FWM) and food operations efficiency (FOE); a moderate positive correlation between food operations sustainability (FOS) and food waste management (FWM); and a moderate positive correlation between FOS and FOE. Furthermore, the research showed that the relationship between food operations sustainability and food operations efficiency is not moderated by food waste management. Lastly, hospitality managers should implement best practices of sustainable food operations to improve food waste management and food operations efficiency.

**Keywords:** Food operations sustainability; food waste management; food operations efficiency; five-star hotels.

### **Introduction**

In the hospitality sector, sustainability is becoming more and more significant. The willingness of consumers to participate in sustainable consumption has increased (Chen *et al.*, 2012; Ramkissoon *et al.*, 2013; Wang *et al.*, 2018; Trang *et al.*, 2019). Customers are more likely to support companies that practice social responsibility or employ green practices by patronizing their products and services (Lucas & Wilson, 2008; Yan & Yazdanifard, 2014; Ting *et al.*, 2019; Chung, 2020; Kim & Hall, 2020; TM *et al.*, 2021). Furthermore, there is a growing likelihood that they will visit green establishments more frequently (Jeng & Yeh, 2015; Jang *et al.*, 2015; Bacig & Young, 2019); they will be more willing to pay for goods and services that are environmentally friendly (TM *et al.*, 2021; Rondoni & Grasso, 2021); and they will stay at environmentally conscious hotels (Langgat *et al.*, 2023). However, due to both operational and nonoperational issues (Silvennoinen *et al.*, 2015; Wang *et al.*, 2017; Dolnicar & Juvan, 2019), Finally, food waste has become a major concern in the hospitality business (Tostivint *et al.*, 2016).

More efficient waste management is crucial to lowering the quantity of waste produced by the hospitality sector, even if increasing the effectiveness of the use of supplies and raw materials directly influences the performance of enterprises (Pirani & Arafat, 2014; Duric & Topler, 2021). How important it is to constantly plan, oversee, and monitor the amount of food prepared and served to avoid excessive overproduction; this need may be reinforced by keeping track of the amount of waste generated (Silvennoinen *et al.*, 2019). A pre-ordering meal system would also make it possible to reduce food waste associated with overproduction and meal preparation (Lorenz *et al.*, 2020). The bad practices in the hotel sector, like subpar construction, subpar customer service, and subpar maintenance design, will have a negative impact on the environment (Prakash *et al.*, 2023). This calls for efficient, sustainable operations in which hotels' total

performance is impacted by waste management strategies (Arici *et al.*, 2023). Finally, the efficiency of hotel operations is impacted by green practice implementation, sustainable growth, and effective management (Prakash *et al.*, 2023).

Green and corporate social responsibility (CSR) practices can help hospitality establishments gain a competitive edge (Jang *et al.*, 2015); improve the sustainability of goods/services (Jacobs & Klosse, 2016); eliminate negative environmental effects by using recycled packaging and sourcing more food organically (Hollis, 2018); improve overall performance (Langgat *et al.*, 2023; Arici *et al.*, 2023); promote rapid economic expansion (Liu *et al.*, 2023); and cultivate a favorable reputation or attract customers (Nguyen & Chiu, 2023). According to earlier research, the hospitality industry's managers, staff, and customers all view sustainability as a critical concern. As a result, hospitality establishments need to be aware of how sustainability affects food waste management and operational efficiency. As a result, the research aims to investigate the relationships among food operations efficiency, food waste management, and sustainability in five-star hotels in the greater Cairo area.

## Literature Review

The globe is currently experiencing several crises, which have led to a global trend in the discussion of sustainability. The population is growing, and the food consumption is rising. Consequently, these trends may affect on environment and climate change (UNEP, 2010). Over the past few decades, governments, corporations, and civil society have all come to see sustainable development as essential due to rising concerns about population increase, resource scarcity, and climate change (Georgiadou & Hacking, 2012). Furthermore, food accounts for approximately one-fifth of the greenhouse gas emissions from goods consumed in the United Kingdom (UK), with meat and dairy being the main contributors (Scarborough *et al.*, 2012). Roughly 14% of the world's greenhouse gas (GHG) emissions come from the agri-food sector alone (FAO, 2017). Thus, one of the key concerns that underpin sustainable growth for every company is carbon management and emissions (UNEP, 2019). As plastic pollution of the environment is pervasive and approximately 40% of all plastic waste produced globally is used in single-use products with only 9% being recycled, the practical use of plastic containers has become a serious environmental problem (Kim & Yun, 2019). Since plastic pollution of the environment is pervasive and only 9% of plastic garbage produced globally is recycled, about 40% of all plastic waste is utilized in single-use items (Hidalgo-Crespo, *et al.*, 2022).

According to Godenau *et al.* (2020), food insecurity is a serious worldwide issue that affects food distribution, availability, and access. The Food and Agricultural Organization (FAO) estimates that in 2020, approximately 12% of the world's population experienced acute food insecurity and that there are 768 million hungry people worldwide, or roughly 9.9% of the total population (FAO *et al.*, 2021). Furthermore, 50–80% of the income of the impoverished in developing nations goes toward food, leaving them vulnerable to price instability and food insecurity (UNEP, 2021). Food waste is another worldwide issue since it indicates a significant inefficiency in the world food chain. According to Corrado & Sala (2018), the range of current estimates for food loss and waste creation is between 194–389 kg per person per year at the world size and between 158–298 kg per person per year at the European scale. Food waste (FW) is undoubtedly a significant environmental and economic issue in the twenty-first century. Approximately one-third of the two billion tons of municipal solid garbage generated annually worldwide is not properly managed (World Bank, 2019).

Life cycle assessment (LCA) offers intriguing prospects for designing sustainable consumption policies and activities that policymakers are not yet fully aware of (Hertwich, 2005). Furthermore, there is no denying the unquestionable need for technologies, as changing consumer behavior may help reduce emissions from food consumption. By changing the way that food products are

consumed, one can drastically minimize the environmental impact of their food intake, including the influence on climate change (Carlsson-Kanyama & Gonzalez, 2009). More work is required to encourage organizations to embrace methods linked to food loss and waste (Corrado & Sala, 2018). Thus, in the global economy, the idea of sustainable development is becoming more and more significant. International initiatives are therefore made to lessen industry's detrimental effects on the environment while increasing industrial efficiency (Karwacka *et al.*, 2020). Nations are moving toward a circular economy in response to global sustainability issues such as resource shortages and population growth (KPMG, 2020). As a result, several European projects and programs have emphasized the significance of encouraging and growing sustainable activities (Rondoni & Grasso, 2021). Reducing carbon emissions, improving environmental effects, and improving food safety are the goals of effective food supply chain management (Shabir *et al.*, 2023). Lastly, when conducting sustainability research using sustainability indicators like the carbon footprint, it is critical to look at sustainability criteria like climate change, energy consumption, user waste production, and the advancement of manufacturing and recycling operations (Shabir *et al.*, 2023).

From the perspective of the customer, a significant number of Finnish customers (five percent of the respondents) in the 2009 Eurobarometer poll felt that they knew little to nothing about the environmental effects of food (European Commission, 2009). Consumers' concerns regarding the potential environmental impact of their daily actions have grown recently (Lim *et al.*, 2017). Customers are more driven to purchase goods from businesses that use green practices (Lucas & Wilson, 2008; Ting *et al.*, 2019). Pro-ecological and pro-social consumption behavior is becoming more prevalent among today's millennials, generation Z, and green generation (Choudhary, 2020). Furthermore, buyers who care deeply about the environment also frequently choose goods that satisfy their needs and demonstrate their social duty (Kim & Hall, 2020). Although they are willing to pay more for environmentally friendly goods and services at restaurants (TM *et al.*, 2021), their understanding of carbon measurements is still lacking. Customers from rising nations such as China and Egypt, for instance, also exhibit a favorable attitude toward carbon footprint information; therefore, a system of carbon footprint labels ought to be established in these countries as well. Nonetheless, consumers have the lowest willingness to pay for carbon footprint information when it is offered alongside other labels (such as organic, fair trade, etc.). Furthermore, consumers who show greater care for the environment and those who often purchase meals with eco-friendly labels are willing to pay a premium for items with a carbon footprint label (Rondoni & Grasso, 2021). Last but not least, there is ongoing demand from patrons for the hotel industry to embrace green practices. Customers now favor staying at environmentally conscious hotels. This implies that hotels might enhance their overall performance by drawing in environmentally conscious clientele by implementing ecologically friendly practices (Langgat *et al.*, 2023).

A 19% decrease in greenhouse gas emissions can be achieved by replacing meat and dairy products with fruits, vegetables, and grains (Scarborough *et al.*, 2012). When analyzing sustainability factors including global warming, energy use, user waste production, and improvements in manufacturing and recycling processes, carbon footprint (CF) is essential. The notion of carbon footprinting is now widely accepted outside of academia, as carbon emissions are inextricably related to lifestyle and consumption choices (Zhong *et al.*, 2019). Increasing carbon emissions are the primary cause of global climate change, endangering both human security and environmental systems. Over 60% of the world's population is expected to live in cities by 2050, and 70–80% of energy consumption and energy-related carbon dioxide (CO<sub>2</sub>) emissions come from urban regions (Gilles *et al.*, 2021). Meat makes up more than 20% of the carbon footprint (CF) associated with all food waste, according to the Food and Agriculture Organization (FAO), and its carbon footprint is several to several dozen times more than that of most fruits and vegetables (Nejad *et al.*, 2021). In addition to providing an alternative to animal proteins, plant, insect, and lab-based proteins also help create a more sustainable circular economy by better utilizing their byproducts (Vauterin *et*

*et al.*, 2021). Additionally, manufacturers can display information about the environmental effects of their food production using carbon footprint labels, which also assist consumers in making more environmentally friendly decisions (Rondoni & Grasso, 2021). Lastly, since the metrics of water footprint (WF) and carbon footprint (CF) are closely related to the life cycle management phenomenon, companies may use them as sustainability indicators (Hidalgo-Crespo *et al.*, 2022). Concerns about food waste's impact on the environment and other global environmental protection have long existed (FAO, 1981). Enhancing the sustainability of the world's food systems is of utmost importance. Furthermore, because of improving living standards and an expanding global population, the world's food supply will need to increase by 70% to 100% in the upcoming decades (Godfray *et al.*, 2010). Currently, almost one-third of the food produced for human consumption is wasted worldwide (FAO, 2011). Food security is threatened by food waste, which also leads to contamination of the environment and the depletion of natural resources (Foley *et al.*, 2011). Given that food production and consumption are among the key worldwide drivers of the environment and global health, this presents a significant issue (Tilman & Clark, 2014). Because of this, the "problem" of food—how much, what kind, how, or by whom it is produced—has recently gained international attention (Garnett, 2014). The United Nations has declared that cutting per capita food waste in half by 2030 is one of its sustainable development goals (target 12.3) because it is now well-established that doing so can lead to a "win-win" situation for both environmental sustainability and nutrition security (United Nation, 2015). To ensure that there is healthy food available everywhere and that the Earth's environmental planetary boundaries (Steffen *et al.*, 2015) are not crossed, it can be very helpful to reduce food loss and waste by 50% (Willett *et al.*, 2019). Furthermore, the yearly cost of food waste (FW) worldwide is estimated to be around 2.6 trillion dollars, taking into account the expenditures connected with the problem on the social, environmental, and economic fronts (FAO, 2014). It is well known that losses or waste occur throughout the food supply chain, accounting for roughly one-third of the world's food production, or 1.3 billion tons annually (Gustavsson *et al.*, 2011; Corrado *et al.*, 2019). With an average annual food waste of 32 kg per capita worldwide, the food service sector ranks third in terms of food waste production, behind households and the food processing sectors (FAO, 2019 & UNEP, 2021). Food waste has detrimental effects on the environment, society, and economy (Principato *et al.*, 2020; Vargas *et al.*, 2021).

Restaurants are by no means environmentally friendly, according to the hospitality sector. In addition to consuming massive amounts of water and energy, they also produce vast amounts of food waste, plastic waste, and emissions (Kasim & Ismail, 2012). For instance, according to Wilcox *et al.* (2016), the majority of single-use plastic cutlery ends up in the ocean. Food waste accounts for around 12% of total waste in the hospitality business. Consequently, it has grown to be a significant issue (Tostivint *et al.*, 2016). According to recent studies, there is a considerable quantity of food waste (FW) in the kitchens of hospitality suppliers and on the plates of their patrons as a result of both operational and nonoperational problems (Silvennoinen *et al.*, 2015; Wang *et al.*, 2017; Dolnicar & Juvan, 2019). In the United States alone, restaurants discard almost 390,000 tons of edible food annually, according to a 2018 estimate. This is a staggering amount of trash that, if properly recovered, could supply nearly 643 million meals to those in need (Cochran *et al.*, 2018). Moreover, Tenenbaum (2019) reports that around 40 billion pieces of non-biodegradable silverware are discarded annually. On the demand side, diners are becoming more conscious of their environmental impact and are increasingly likely to frequent eateries that use green techniques (Jang *et al.*, 2015; Bacig & Young, 2019). In academic circles, there has also been a comparable surge in interest in comprehending the environmental unsustainability of restaurants. Recent review studies on sustainability challenges in the hospitality industry have been published to make this clear (Filimonau & De-Coteau, 2019; Higgins-Desbiolles *et al.*, 2019). The food service sector is in charge of preparing and delivering meals that satisfy customers' nutritional needs while taking sociocultural, safety, and sensory considerations into account. Meals served for

consumption outside the home have increased in number in recent years (FIPE, 2019). The volume of food waste is increasing exponentially at the same time, highlighting the importance of this issue as a priority of the research agenda (Principato *et al.*, 2021).

Sustainability has been positioned as the defining feature of the last ten years in the hospitality sector (Badhotiya *et al.*, 2016). Furthermore, this underscores the significance of sustainability in the hospitality sector (Jacobs & Klosse, 2016) and emphasizes the need to continuously plan, manage, and oversee the quantity of food prepared and served to prevent unnecessary overproduction, which may be bolstered by waste amount measurements (Silvennoinen *et al.*, 2019). Restaurants are becoming more conscious of sustainability issues as anthropogenic greenhouse gas emissions from food systems account for about 34% of emissions. They are also becoming more concerned about food waste and packaging (Huang *et al.*, 2023). The hotel business is rebounding from the COVID-19 pandemic. The industry has seen new trends since this comeback. Travelers now expect hotels to be "greener" or more environmentally friendly. The industry needs to remember its environmental duties and sustainability in light of the growing demand for eco-friendliness (Susilo *et al.*, 2023). Changes in ecological deterioration are what drive the hotel industry and achieving realistic development targets is essential. Green, hygienic, and health-conscious methods are crucial in the hotel industry these days. As a result of the economy's volatility and the government's and the corporate sector's lack of commitment to customer loyalty, hotels are compelled to implement green practices (Prakash *et al.*, 2023).

Restaurant operators need to be aware of how fine-dining establishments can maintain sustainable operations in the face of intense competition given the current rapid economic expansion (Liu *et al.*, 2023). The amount of municipal garbage produced by the hospitality industry is now a major sustainability issue for travel locations. Ambitious sectorial initiatives to reduce waste creation will necessitate expensive transformations of municipal garbage services in addition to internal operations adjustments in the hospitality industry. Interestingly, it is discovered that employee training outperforms alternative waste management measures in terms of prevention (Diaz-Farina *et al.*, 2023).

More specifically, consumers are driven to purchase goods from businesses that use environmentally friendly practices (Lucas & Wilson, 2008; Ting *et al.*, 2019). Customers' recognition that their actions have an impact on the environment's health serves as the source of this motivation. In other words, they believe that they should be accountable for the products and companies that they support (Szakály *et al.*, 2017). The increasing consciousness and care for ecological matters impact customers' inclinations towards choosing eco-friendly dining establishments (Jeng & Yeh, 2015) and purchasing eco-friendly merchandise (Chung, 2020). As a result, owners of restaurants are implementing eco-friendly procedures that draw clients and reduce their negative effects on the environment. For example, eateries now provide more food that is sourced organically and use recycled packaging (Hollis, 2018). Furthermore, they are replacing plastics and polystyrene foams with biodegradable substitutes (Helmer, 2019). Restaurants can benefit from the eco-conscious trend by implementing and promoting green and corporate social responsibility (CSR) practices, which can provide them with a competitive edge (Jang *et al.*, 2015). Green plans stress waste reduction and eco-friendly packaging, whereas CSR strategies highlight how restaurant owners serve their communities by organizing events, such as tree planting, and fundraisers. The different levels of green consumerism affect both the decisions made for purchases and the willingness to pay higher costs (Yan & Yazdanifard, 2014). Consumers who care deeply about the environment are more likely to buy goods that satisfy their needs and demonstrate social responsibility (Kim & Hall, 2020). Customers frequently criticize hospitality businesses because of their social participation because these enterprises are tangible. Restaurants frequently use CSR programs as marketing tactics to build a positive reputation and draw patrons (Nguyen & Chiu, 2023).

Customers who frequent sustainable restaurants can express their ideals, which fosters the development of behavioral and emotional ties between them and the establishments (Jang *et al.*, 2015). As a result, restaurants can foster enduring relationships with patrons and promote advocacy and favorable views by implementing green practices and developing CSR initiatives (Pérez *et al.*, 2019). Restaurant patrons who care about the environment are prepared to spend more on environmentally friendly goods and services (T.M. *et al.*, 2021). Additionally, because some previous studies have integrated green and CSR activities into one construct, it is unclear which activity influences consumers' views and behavioral intentions (Zhang *et al.*, 2022; Elshaer *et al.*, 2023).

Throughout the entire food supply chain, seven factors contribute to food waste: market requirements, food safety-related rules and regulations, market behaviors, human mistakes, technical issues, lengthy logistics delivery times, and cultural impacts. Food waste can result from all of these (Göbel *et al.*, 2015). According to Aschemann-Witzel *et al.* (2017), the issue of food waste can be resolved by altering the way the supply chain functions while keeping in mind the need to reduce food waste and influence customer decisions. Food waste can arise not only during the consuming phase of the supply chain but also in restaurants and associated preparation procedures, including errors in recipe formulation, incorrect handling of food ingredients, or expired food (Sakaguchi *et al.*, 2018).

Specifically, Corrado & Sala (2018) noted that the majority of food waste occurred at the consuming stage and that the weight of food wasted per person annually varied from 194 to 389 kg throughout the global food supply chain. Additionally, when it comes to the percentage of waste in the various food categories worldwide, grain waste made up 24%, rhizome waste was 6%, vegetable waste was 25%, fruit waste was 12%, dairy products waste was 9%, meat and fish waste was 5%, and other parts made up 19%. Additionally, it was shown that compared to the USA and Europe, East Asian and Pacific countries have considerably higher levels of vegetable waste (Chen *et al.*, 2020). Although regulating food consumption demand—that is, people's eating habits—may yield significant co-benefits from a land, water, and energy standpoint, many efforts have focused on the production side (Godfray *et al.*, 2010). Given the predicted increasing competition for land, water, energy, and other inputs, people's eating habits have a significant impact on how resources are used (Garnett *et al.*, 2013; Tilman & Clark, 2014).

Water is currently one of the main constraints restricting agricultural productivity (Yang & Cui, 2014), and competition for water causes water scarcity issues to worsen in many locations and river basins (Jalava *et al.*, 2014). Depending on their relationship with food, their gastronomic preferences, their emotional state, and their level of hunger during meals, consumers waste food for different reasons (Lorenz *et al.*, 2017; Principato *et al.*, 2021; Rohm *et al.*, 2017). However, when it comes to kitchen food waste, the primary cause is the inability to accurately estimate daily food consumption, which leads to over-preparation and excess food (Papargyropoulou *et al.*, 2016; Principato *et al.*, 2021; Silvennoinen *et al.*, 2019). This emphasizes how crucial it is to continuously plan, manage, and keep an eye on how much food is made and served to prevent excessive overproduction, which may be bolstered by tracking the quantity of trash produced (Silvennoinen *et al.*, 2019). Furthermore, a pre-ordering meal system would enable a decrease in food waste related to overproduction and meal planning (Lorenz *et al.*, 2020). But in addition to improved preparation and oversight, customers must select the right amounts according to their needs and appetite (Pires *et al.*, 2022). Thus, implementing weight-based meal pricing could help reduce food waste in the workplace canteen by encouraging employees to choose their meals more carefully and become more flexible in determining the right portion sizes (Lorenz *et al.* 2020). According to Pires *et al.* (2022), customers are more likely to be exact and cautious when determining how much food to put on their plates because they are sensitive to financial incentives like paying for the amount that is served. In addition, the literature indicates that meal acceptance,

meal sensory attributes, and dislike of flavor are other factors that affect food waste at workplace canteens (Pires *et al.*, 2022).

Similarly, Lorenz *et al.* (2017) found that plate leftovers from a catering business were significantly influenced by flavor, highlighting the importance of enhancing meal quality to influence food waste from customers. It's interesting to note that when a meal is provided for free, food waste typically increases (Salute, 2018). The "Restaurant Food Waste Map" (RFWM) is a tool used by restaurants that tries to emphasize mitigation efforts of food waste-generating processes in the restaurant industry as well as define the steps in which food waste occurs. In actuality, Principato *et al.* (2021) distinguish three stages in which the food waste phenomena take place: food preparation in the kitchen; food service; and client consumption. The environment and sustainability are seriously threatened by a variety of issues, including the greenhouse effect, pollution of the air, water, and soil, species extinction and loss, and depletion of natural resources (Wang *et al.*, 2020; Xu *et al.*, 2020). The majority of the issues are related to human actions that are environmentally harmful (Hopkins, 2020; Steg & Vlek, 2009; Xu *et al.*, 2020; Wu *et al.*, 2020). Scholars concur that modifying human behavior in an environmentally sustainable way can help manage and address troublesome issues (Han, 2020; Steg & Vlek, 2009). Environmental sustainability mostly depends on people changing their consumption habits, namely how they view, purchase, and use items in an environmentally friendly way (Halder *et al.*, 2020; Wang *et al.*, 2020).

In the hotel industry, sustainable consumption is starting to gain traction (Kiatkawsin & Han, 2017; Wang *et al.*, 2020). The awareness of the connection between tourism development and major environmental deterioration is growing in the marketplace (Trang *et al.*, 2019; Wang *et al.*, 2020). As a result, eco-friendly consumption and sustainable product development are becoming more crucial than ever in the modern tourism and hospitality sector. These days, consumers in this industry are more willing to engage in sustainable consumption and are increasingly demanding green products (such as ecologically conscious hotels, restaurants, cruises, airlines, destinations, resorts, conferences, and casinos) (Chen *et al.*, 2012; Ramkissoon *et al.*, 2013; Trang *et al.*, 2019; Wang *et al.*, 2018). Many hospitality businesses are exhibiting a tendency to become more proactive in greening their operations and products as a result of this demand and the eco-conscious market environment (Afifah & Asnan, 2015; Hopkins, 2020; Lee *et al.*, 2013). At the same time, customers in the hospitality industry are learning that environmentally friendly actions are inevitable in both their daily lives and the conditions in which they consume products (Choi *et al.*, 2015; Wang *et al.*, 2018; Xu *et al.*, 2020).

Although short supply chains and local food systems are frequently used synonymously, there are differences between the two. Although "where the local area ends and another scale begins is subjective, depending on context (density of populations, accessibility, and rural or urban character for example) and purpose," local food systems "produce, process, and retail within a defined geographical area" and "the local is always experienced and understood about larger geographical scales, such as the national or global" (Kneafsey *et al.*, 2013). According to Markuszewska *et al.* (2012), "local" is "the smallest unit used to describe the origin of food" and a consumer "would recognize a difference between the terms 'local' and 'regional' when describing the origin of food" if they are at least "personally familiar with the place where the food is produced". Moreover, there is growing pressure on the hospitality sector to pay more attention to social and environmental issues. Consequently, managers of hospitality are starting to realize that their environmental policies are critical to sustainability and long-term economic growth (Cingoski & Petrevska, 2018; Erdogan & Baris, 2007; Mensah, 2014). Water conservation and reuse, integrated energy efficiency, material consumption reduction, and solid waste mitigation are the most often used environmental strategies in the hospitality sector. They cover the usage of eco-friendly products (Pereira-Moliner *et al.*, 2021) and tackle difficult problems such as growing food waste and single-use plastics, particularly in the wake of the COVID-19 epidemic (Filimonau, 2021).

Even though improving the efficiency of the use of supplies and raw materials directly affects the performance of businesses, more effective waste management is essential to reducing the amount of trash generated by the hospitality industry (Pirani & Arafat, 2014; Duric & Topler, 2021). As per the 2009 Eurobarometer poll, a significant segment of Finnish customers, comprising 55% of the participants, hold the belief that they possess minimal or no knowledge regarding the ecological consequences of food. Environmental labeling is one method of educating customers about the effects of food on the environment. Labels on packaging inform and direct consumers about the features of the product (European Commission, 2009). Finnish customers do not significantly associate food with environmental sustainability, and often misunderstand what a product's carbon footprint means. As a result, environmental friendliness is not as important as many other qualities. Thus, it is evident that customers need to be informed about how food affects the environment (Hartikainen *et al.*, 2014).

Sustainability has been positioned as the defining feature of the last ten years in the hotel sector. It promotes the widespread adoption of eco-friendly measures such as getting rid of plastic waste products, cutting down on needless resource use, decreasing food waste, and other environmental concerns. With the current state of growth, it is critical to develop, discuss, and look for strategies that can provide long-term effects. Green management must be implemented into supply chains because of government regulations governing this industry (Badhotiya *et al.*, 2016). Sustainability is becoming more and more important in the hospitality sector. Sustainability research ought to support the hotel sector and improve the sustainability of its goods (Jacobs & Klosse, 2016). Food waste is a major concern on a worldwide and European scale. The key difficulty that needs to be tackled is identifying the factors that generate FW, as this is crucial for appropriately building the framework for primary data collecting and establishing reduction techniques that work (Caldeira *et al.*, 2017).

Within the hospitality sector, there is an increasing focus on sustainability. Jacobs & Klosse (2016) suggest that the hospitality sector can be strengthened, and its goods made more sustainable through sustainability research. On a worldwide and European scale, food waste (FW) is a top concern. Finding the FW drivers is a major difficulty that must be solved since it is crucial to developing efficient reduction plans and appropriately constructing the framework for collecting primary data (Caldeira *et al.*, 2017). A significant portion of the food industry's environmental effect is attributable to food waste. As a result, initiatives to cut down on food waste have a significant chance of strengthening the food and agriculture supply chains' sustainability. Food waste resulting from consumers is a complicated problem that requires cooperation between many supply chain participants and industry stakeholders. Three programs are in place to deal with food waste. While the second and third types largely focus on changing the context in which consumers make food choices, they also incorporate elements of raising awareness. The first kind is primarily concerned with persuading consumers to avoid food waste and strengthening their capacities. Future efforts should be inspired by current ones, with particular attention to selecting the appropriate partners and capabilities, starting the initiative at the appropriate time, and aiming for large-scale implementation as soon as possible (Aschemann-Witzel *et al.*, 2017).

The foodstuffs that make up the most portion of all food waste are dairy products (21%) and meat, fish, and animal fats (26%). Based on these findings, a return to a Mediterranean diet that emphasizes a higher proportion of fruits and vegetables in the diet will result in more water savings (Blas *et al.*, 2018). Cutting down on food waste can help achieve some sustainable development goals (SDGs). In particular, food waste from various nations varies greatly in terms of nutrients and environmental impact, necessitating waste reduction strategies tailored to each nation (Chen *et al.*, 2020). Furthermore, to find out if a restaurant's inclination toward environmental sustainability was influenced by its attributes like chain affiliation or restaurant type, Jang & Zheng (2020) looked at the present levels of environmental sustainability in restaurants across the United States. This study also emphasizes how various restaurant categories differ in terms of



environmental sustainability. Additionally, there are occasions when it is proposed to enhance the environmental impact of the food system as well as boost its resilience example, during the COVID-19 pandemic encouraging local food systems and short supply chains.

According to Abdelmawgoud & Abdelnaby's (2020) study, there was a high degree of overall customer trust in the food offered at the hotels in Luxor, Aswan, and Cairo. It also recommends that hotels improve their consumption of organic food and incorporate it into their marketing strategy, as well as relying on food items from accredited international organizations. In addition, Abdelmawgoud's study (2020), first-, second-, and third-stage students are more aware of their nutritional habits than fourth-year students. Moreover, Stein & Santini (2021) shows that local food cannot always be considered sustainable; it rarely guarantees food security and does not always have a lower carbon footprint. Transportation is not the only issue that affects how environmentally sustainable food systems are; dietary choices made by customers are also important. Local food systems can support rural development and a sense of community, but they are not always more resilient in terms of social sustainability. Regarding economic sustainability, some farmers may profit from selling into local markets through short supply chains, while other producers may find it more advantageous to supply markets abroad.

The tourism and hospitality industries of today are focused on environmental sustainability. Environmentally friendly consumer behavior is crucial to protecting the environment, which in the end helps society. The primary motivators of environmentally sustainable consumer behavior, including perceived effectiveness, connectedness to nature, green value, green image, pro-environmental behavior in daily life, environmental knowledge, green product attachment, descriptive social norms, and expected feelings of guilt and pride (Han, 2021). The majority of packaging materials are produced using polymers derived from fossil fuels, which greatly increases greenhouse gas emissions. The carbon and energy footprints may be reduced by replacing traditional fossil fuels with bio-based substitutes (Nejad *et al.*, 2021). Sustainable packaging should be utilized to guarantee the long-term sustainability of the food cycle, including production, packing, and disposal (Rondoni & Grasso, 2021). Furthermore, Ababneh's (2021) study offers novel insights suggesting that employee engagement plays a partial mediating role in the relationship between eco-friendly HRM practices and eco-friendly individual behavior. Furthermore, it underscores the significance of interpersonal interactions inside an organization in cultivating staff involvement in environmental projects.

Furthermore, according to Madanagulia *et al.* (2022), research on green restaurants has advanced past its infancy and has risen rapidly in recent years. Five major thematic foci are revealed by a thorough qualitative content analysis: stakeholders and their roles, environmental unsustainability sources, green initiatives restaurants adopt to address environmental unsustainability, results of adopting green practices, and different approaches to measuring greening practices. The study of Vu *et al.* (2022) explores the perspectives of Australian and Vietnamese chefs on sustainability in their respective contexts, explores ways to improve sustainability, and examines the obstacles that stand in the way of more robust sustainable practices. For example, although both groups felt firmly that improving sustainability required working with the supply chain, they were obviously at odds when it came to cut down on food waste or being more receptive to conversations about sustainability.

Achieving realistic development targets is essential, as the hotel business is driven by shifting ecological degradation (Prakash *et al.*, 2023). Precision agriculture can increase food processing efficiency while lowering carbon emissions; the use of renewable energy lowers the carbon footprint of food processing; the use of bioplastics made from plants and recyclable materials lowers the carbon footprint of packaging; and transportation emissions were reduced by streamlining the supply chain and logistics. To lower the carbon footprint index, new food production techniques are being developed, existing agricultural practices are being improved, and more consumers are choosing ecologically friendly products (Shabir *et al.*, 2023).

Green, hygienic, and health-conscious methods are vital in the hospitality and hotel industry these days. The report highlights the need for improved management, sustainable growth, and the implementation of green practices in the Indian hotel sector, with a focus on reducing carbon emissions. The primary objectives of the critical performance indicators (CPIs) are risk avoidance and optimal return on investment maximization. By limiting carbon emissions through green measures, the hotel industry's development will be greatly enhanced. Furthermore, the necessity of assessing and improving the hotel industry's current business processes, which make significant contributions to the hospitality sector. Negative environmental effects will result from the evil activities in the hotel industry, such as poor building, poor service, and poor maintenance design. The environmental conditions and declining green practice ratings of the Indian hotel business are thus at risk due to the practices resulting from superficial planning. Thus, models that are sustainable and beneficial to the environment must be created for the Indian hotel sector. For Indian hotels to expand sustainably, consideration must be given to both energy usage and the resulting carbon emissions (Prakash *et al.*, 2023).

To investigate management attitudes and awareness towards green logistics, Leung *et al.* (2023) develop a paradigm that follows a behavioral driving path and incorporates interactions among green "attitudes," sustainable "subjective norms," "behavioral control," and "external context" elements. Furthermore, Bharwani & Mathews (2023) noted that luxury hotels are under growing pressure to consider how their activities affect social and environmental sustainability. Furthermore, luxury hotel businesses in India are progressively incorporating sustainable methods and eco-friendly items into their daily operations. Nonetheless, a few of these projects are in non-customer-facing fields like engineering and back-of-house operations. To enhance their hotels' green image, very few Indian hotel chains are incorporating these sustainability measures into their basic philosophies and integrating them into the front-line guest service experience at their establishments. Lastly, Arici *et al.* (2023) found themes and concepts related to environmental sustainability by looking at TripAdvisor consumers' green reviews. It was discovered that the most frequently cited topics in the positive reviews left by customers include room, every day, hotel, personnel, front, food, and coffee, fantastic, experience, and vacation. The findings also revealed that Germany and France had the lowest satisfaction ratings, while Italy, the USA, and Turkey had the highest rankings. The findings offer crucial suggestions for hotel operators to fully understand what eco-friendly actions are observed and valued by their clientele. In their study, Langgat *et al.* (2023) investigate whether implementing sustainable practices in hotel restaurants has an impact on the overall performance of hotels, as well as the factors of innovation, organization, and external environment that influence this decision. The findings imply that the main factors influencing the adoption of sustainable practices, such as assistance for host communities, waste management, and conservation initiatives, are simplicity of use and support from top management. Furthermore, this study discovered that waste management techniques and support for host communities had an impact on hotels' overall performance.

According to Liu *et al.* (2023), actual, ideal, and ideal social self-image congruity was induced by the atmosphere and food quality, whereas social self-image congruity and WTP-PP were significantly positively impacted by the quality of the service in addition to the three aspects of self-consistency mentioned above. In the meantime, both ideal and actual self-image congruency had a major impact on WTP-PP. Moreover, Gen Y was more concerned with the quality of the atmosphere than Gen X was. In contrast to Gen Y, Gen X placed a higher importance on food quality. Furthermore, according to Suttikun & Mahasuweerachai (2023), customers' emotional attachment to restaurants is a result of green and corporate social responsibility (CSR) strategies, and this attachment influences their advocacy and readiness to pay premium prices (WTP). Additionally, there is a strong moderating influence of the perceived seriousness of environmental problems (PSEP) and ascription of responsibility (AR) on the emotional connection of consumers to green measures. Restaurant image is influenced by consumers' views of green strategies, which

are influenced by social media techniques and status consumption. The moderating effect of social media on customers' views of green strategies was examined concerning uniqueness. According to the findings, patrons who value originality highly are more likely than those who value it less to be aware of restaurants that use eco-friendly practices.

Due to growing worries about packaging and food waste, as well as the fact that 34% of anthropogenic greenhouse gas emissions originate from food system life cycles, the restaurant business is becoming more conscious of sustainability issues. The findings indicate that while Michelin Green Star Restaurants (MGSRs) are currently modestly promoting sustainability, they have the potential to be ambassadors and supporters of sustainability. While some MGSRs do practice sustainability, most of their websites emphasize the local and organic food options they offer, with less focus on sustainable food preparation methods. According to this study, restaurants could promote sustainability by including sustainable practices on both their websites and "customer's plates" (Huang *et al.*, 2023). To assess food waste throughout the meal preparation process for Taiwanese hospitality students, a recent study developed a behavioral observation scale for avoiding food waste from the perspective of Chinese cuisine. Both the students and the observers felt that there was room for improvement in the cooking process when it came to minimizing water waste, eliminating extra edible pieces, cutting back on seasoning waste, avoiding overcooking, and preventing water stains during the washing phase. The study's findings will aid in understanding the teaching strategy that aims to prevent pupils from wasting food (Ko & Hong, 2023).

Although there are differences in how hotels approach the SDGs, the study of Chang *et al.* (2023) demonstrated that the hotel industry is dedicated to its goals. Since hotels have been shown to contribute to the three primary spheres of sustainability—the economy, society, and environment—they have examined and addressed the majority of the Sustainable Development Goals (SDGs). The seven hotel chains that are the subject of this profile accept accountability for taking environmentally friendly, sustainable measures. The effects of these behaviors are favorable for visitors, employees, and hotel owners. The results could provide direction for hotels that have not yet committed to putting the SDG targets into practice. The UN Sustainable Development Goals involve halving per capita food waste by 2030 because, according to Principato *et al.* (2023), doing so is crucial to building a more sustainable food system. They demonstrated the decline in food loss and waste over time, which has had a positive impact on the environment. They also highlighted the distinctions between food left on staff plates and food lost during meal preparation. Therefore, to increase knowledge of the behavioral strengths and limitations of kitchen and catering staff as well as employees, it is crucial to develop education efforts and use digital technologies to communicate food-related data acquired within firms.

According to Joshua *et al.* (2023), a psychological mechanism underlies employees' perceptions of their restaurants' orientation on environmental concerns; connecting the restaurants' green attributes to employees' green behaviors. This relationship is diminished by employees' eco-anxiety for voluntary green behaviors, whereas there is no significant moderation for required green behavior. Ultimately, Diaz-Farina *et al.* (2023) found that the effects vary depending on the meal plans provided and that the nature of the accommodation and structural services in flats leads to a higher creation of mixed trash compared to hotels. Interestingly, it is discovered that employee training outperforms alternative waste management techniques in terms of prevention. Advocates for significant modifications to the structure of municipal garbage charges, they also offer recommendations to encourage participation and highlight prospects for collaboration between legislators and hotel operators. Finally, Diaz-Farina *et al.*, (2023) revealed that impacts differ according to the meal plans offered and that mixed-waste generation is higher in apartments than in hotels due to the accommodation and structural services nature. Notably, employee training is found to have a greater prevention effect than alternative waste management strategies. They advocate profound changes in municipal waste charge design and provide guidelines to facilitate

engagement, underlining opportunities for cooperation between policymakers and hospitality managers.

## Methodology

This research aims to investigate the relationships among food operations sustainability (FOS), food waste management (FWM), and food operations efficiency (FOE). Consequently, the research methodology is analytical, and the population of this research is the staff (managers and employees) of five-star hotels in the greater Cairo area. Therefore, this research was based on the method of random stratified sample. For sample size, the total of five-star hotels in greater Cairo is 32 hotels and the total of staff is 17493. Therefore, the researcher used the equation of Stephan Thompson for the limited population to determine the sample size. Consequently, the size of the sample is 376 according to the equation of Thompson as follows:

$$n = \frac{N \times P(1 - P)}{[N - 1 \times (d^2 \div z^2)] + P(1 - P)}$$

$$n = \frac{17493 \times 0.5(1 - 0.5)}{[17493 - 1 \times (0.0025 \div 3.8416)] + 0.5(1 - 0.5)}$$

$$n = \frac{4373.25}{11.6198} = 376$$

Where:

p = Probability of achieving the studied characteristic in the population (0.5)

z = Confidence Level of 95 % (1.96)

d = Error Proportion (0.05)

n = Sample Size (376)

This indicates that to have a 95% confidence level that the true value is within  $\pm 5\%$  of the measured/surveyed value, 376 or more questionnaires must be completed. According to Thompson's equation, there will be twice as many disseminated questionnaires as there is sample size because the anticipated response rate from the general population is 50%. Consequently, 752 questionnaires have been distributed. Additionally, the sample size's attributes include the following:

**Table (1): The Characteristics of Sample Size**

No.	Characteristics	Items	Value
1	Sample Size	Confidence Level	95 %
2		Margin of Error	5 %
3		Population Proportion	50 %
4		Population Size	17493
5		Sample Size	376
6	Margin of Error	Confidence Level	95 %
7		Sample Size	547
8		Population Proportion	50 %
9		Population Size	17493
10		Margin of Error	4.12 %

Source: Researcher based on <https://www.calculator.net/sample-size-calculator.html>

For research design, the researcher depended on the literature review to develop scales to measure food operations sustainability (Ting *et al.*, 2019; Higgins-Desbiolles *et al.*, 2019; Nejad *et al.*, 2021; Liu *et al.*, 2023; Shabir *et al.*, 2023; Huang *et al.*, 2023), food waste management (Chen *et al.*, 2020; Lorenz *et al.*, 2020; Vargas *et al.*, 2021; Principato *et al.*, 2021; Huang *et al.*, 2023), and food operations efficiency (Hertwich, 2005; Badhotiya *et al.*, 2016; Silvennoinen *et al.*, 2019;

Langgat *et al.*, 2023; Prakash *et al.*, 2023; Diaz-Farina *et al.*, 2023). Therefore, the research tool is a questionnaire that is used to collect data; and to distribute it to the staff of the food and beverage department in five-star hotels in greater Cairo. These staff respond to this questionnaire based on a five-point Likert scale starting from 1 (very low) to 5 (very high). Finally, the researcher uses the SmartPLS (V.4.1.0.0) software to build the model and to determine its validity and reliability. The model consists of three variables as following:

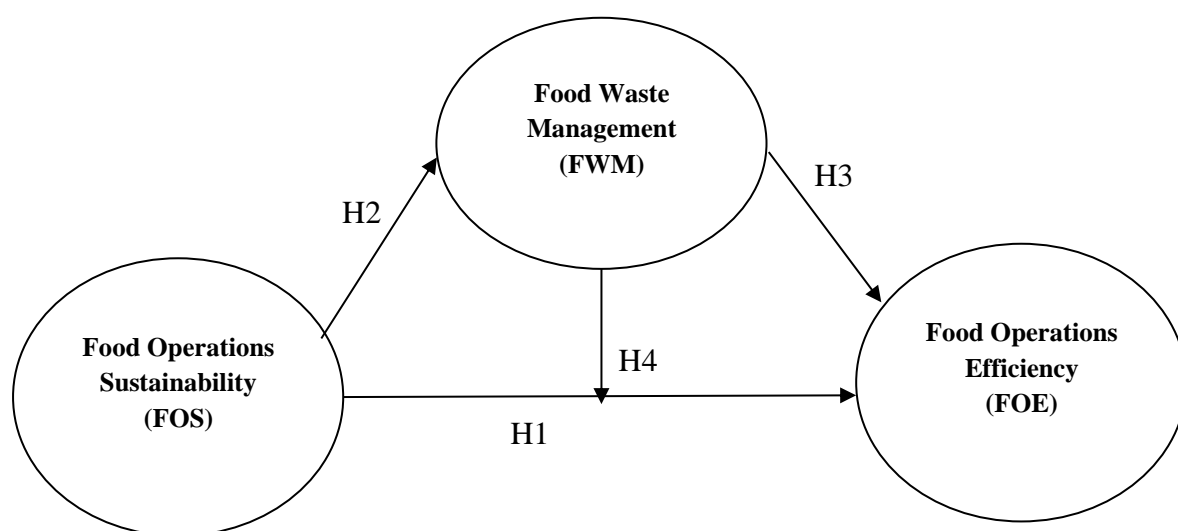
**Table (2): The Variables of Research**

No	Variables	Code	Items
1	<b>Food Operations Sustainability (FOS)</b>	SFP1	Hospitality establishments is replacing an increasing number of imported goods with local alternatives.
2		SFP2	Hospitality establishments harvests at least some produce (such as herbs and vegetables) from its own farm or hotel garden.
3		SFP3	Hospitality establishment organizes seasonal campaigns to raise awareness of seasonal products to guests.
4		SFP4	Hospitality establishment adapts its menus depending on the season.
5		SFP5	Hospitality establishment increases the percentage of use of seasonal products.
6		SFP6	Hospitality establishment attends local food festivals and fairs.
7		SFP7	Hospitality establishment reaches out to local producers and incorporate their local products into planning daily menus.
8		SFP8	Hospitality establishment buys as little unsustainable food as possible, such as beef and airborne produce.
9		SFP9	Hospitality establishments does not use any endangered marine products.
10		SFP10	Hospitality establishment is looking for organic labels.
11		SFP11	Organic food is an important part of a hospitality establishment's menus.
12		SFP12	Hospitality establishment cares about fair food practices along the supply chain and evaluates its suppliers accordingly.
13		SFP13	Hospitality establishment visits trade shows and farmers markets to discover new local suppliers.
14		SFP14	Hospitality establishment communicates with official organizations to obtain the latest developments and updates regarding local products and suppliers in the market.
15		SFP15	Hospitality establishment organizes field trips to hotels with best practices and tries to benefit from their expertise.
16		SFP16	Hospitality establishment buys from producers directly or through trusted suppliers rather than wholesalers to ensure the origin and quality of the products.
17		SFP17	Hospitality establishment supports small, local, and environmentally friendly producers by purchasing their products.
18		SFP18	Hospitality establishment meets its suppliers on a regular basis and builds strong relationships with them.
19		SFS1	Hospitality establishment diversifies its menus and includes seasonal highlights.
20		SFS2	Hospitality establishment focuses on local or regional dishes on its menus.
21		SFS3	Hospitality establishment uses local foods in its main dishes rather than imported foods (for example, American steak).

22		SFS4	Hospitality establishment cooks fresh dishes without using processed foods.
23		SFS5	Hospitality establishment thinks about food production firstly and selects its menu items carefully.
24		SFS6	Hospitality establishment focuses on fruits and vegetables in planning its menus and offers a high degree of variety in all meals, especially snacks.
25		SFS7	Hospitality establishment uses energy-efficient cooking techniques to save water and energy.
26		SFS8	Hospitality establishment offers dietary dishes with reduced portions and sizes in its restaurants.
27		SFS9	Hospitality establishment uses individual portioning, half inserts, and more regular replenishments at their buffets.
28		SFS10	Hospitality establishment presents sustainable menus in an attractive way.
29		SFS11	Hospitality establishment arranges the buffets so that more sustainable foods are available at the buffet center.
30		SFS12	Hospitality establishment highlights organic produce and local regional foods on the name tags at the buffet.
31		SFS13	Hospitality establishment offers many vegetarian alternatives in an attractive way.
32		SFS15	Hospitality establishment implements an active information policy to communicate its sustainable food practices to its guests.
33		SFS16	Hospitality establishment focuses information on important and critical issues and is organized in a clear manner.
34		SFS17	Hospitality establishment highlights specific producers and growing practices using storytelling.
35	Food Waste Management (FWM)	FWM1	Hospitality establishment constantly monitors and measures our food waste, and knows where, when why and how much waste is produced.
36		FWM2	Hospitality establishment works to plan its menus efficiently to avoid food waste.
37		FWM3	Hospitality establishment is improving its menus to ensure cross-use of the same ingredients in different dishes.
38		FWM4	Hospitality establishment establishes good purchasing procedures based on good inventory control and forecasting using tools such as inventory control and purchase list.
39		FWM5	Hospitality establishment prepares items such as bread, cakes, and desserts, so it can control portions on a daily basis.
40		FWM6	Hospitality establishment uses cutting tools creatively to prepare dishes or food items.
41		FWM7	Hospitality establishment offers a special dish of the day to use up stock that is approaching its expiration date.
42		FWM8	Hospitality establishment has methods in place to prevent waste on the buffet and on customer plates.
43		FWM9	Hospitality establishment uses only functional and edible decorations to avoid wasting unnecessary dishes.
44		FWM10	Hospitality establishment provides as many live cooking stations as possible at buffets to reduce food waste.
45		FWM11	Hospitality establishment offers different sizes of food items to suit different tastes of customers.
46		FWM12	Hospitality establishment avoids purchasing products that are overly packaged by, for example, using a large amount of plastic.

47		FWM13	Hospitality establishment is reviewing and utilizing the recycling services provided in its area.
48		FWM14	Hospitality establishment gives customers the opportunity to provide feedback about issues associated with certain types of meals.
49		FWM15	Hospitality establishment redistributes untouched edible foods to those in need.
50		FWM16	Hospitality establishment reuses food that is not fit for human consumption in animal farms and compost.
51	Food Operations Efficiency (FOE)	FOE1	Hospitality establishment works to build awareness among employees about the importance and benefits of sustainable food operations.
52		FOE2	Hospitality establishment offers continuing education and trains employees in sustainable food operations.
53		FOE3	Hospitality establishment stimulates changes and encourages management and employees to continuously innovate and improve operations to achieve greater sustainability.
54		FOE4	Hospitality establishment works to establish long-term relationships with its suppliers.
55		FOE5	Hospitality establishment creates and provides communication tools to communicate its sustainable food strategy to guests and stakeholders.
56		FOE6	Hospitality establishment includes a sustainable food policy in its vision and mission statement.
57		FOE7	Hospitality establishment has an action plan to introduce a more sustainable food policy step by step.
58		FOE8	Hospitality establishment sets targets for all sustainable food standards and monitors them regularly.
59		FOE9	Hospitality establishment provides fair working conditions for all employees.

Based on the aim of this research, Figure (1) below sets out the conceptual framework used in this study:



**Figure (1): The Conceptual Framework of Research**

According to Figure (1), the researcher developed the following hypotheses:

- **H1:** There is a positive relationship between food operations sustainability (FOS) and food operations efficiency (FOE) in five-star hotels in greater Cairo.
- **H2:** There is a positive relationship between food operations sustainability (FOS) and food waste management (FWM) in five-star hotels in greater Cairo.
- **H3:** There is a positive relationship between food waste management (FWM) and food operations efficiency (FOE) in five-star hotels in greater Cairo.
- **H4:** Food waste management (FWM) moderates the relationship between food operations sustainability (FOS) and food operations efficiency (FOE) in five-star hotels in greater Cairo.

### Data Analysis and Results Discussion

There are 564 valid questionnaires. As a result, 75% of respondents responded. The researcher performed component-based structural equation modeling (SEM) using SmartPLS (V.4.1.0.0) and descriptive analysis using SPSS (V. 25) to examine the data that was gathered. The data analysis was conducted by the researcher using a three-step procedure. He started by performing descriptive statistics. To confirm the validity and reliability of the construct, he secondly evaluated the measurement model. After that, he assessed the structural model to make sure the theories could be tested with it. Finally, the researcher employed factor loading, composite reliability, and average variance extracted (AVE) to guarantee that the indicators accurately reflect their latent variables and that the items meet acceptable convergent and discriminant validity. After doing this test, the researcher eliminated 28 items that did not satisfy the necessary standards from food operations efficiency, 4 items from food waste management, and 4 items from food operations sustainability. The final results are shown in this section as follows:

### Descriptive Statistics

By analyzing the research data, the results of the study came as follows; table (3) displays the frequency of respondents' demographic data.

**Table (3): The Frequency of Respondents Demographic Data**

No	Factors	Items	Frequency	Percent
1	Job	Manager	136	24.9
		Employee	410	75.1
2	Gender	Male	477	87.4
		Female	69	12.6
3	Marital Status	Single	182	33.3
		Married	295	54.0
		Divorced	69	12.6
4	Qualification	Diploma or Secondary	135	24.7
		University	205	37.5
		Postgraduate	206	37.7

The frequency of the research participants' demographic information is displayed in Table (3). It turns out that the majority of responders are married (54%), have postgraduate degrees (37.7%), are employed (75.1%), and are male (87.4%). The descriptive statistics for the research variables are displayed in the table (4) that follows.



**Table (4): The Descriptive Statistics of the Research Variables**

No.	Descriptive Statistics		Variables			
			Food Operations Sustainability (FOS)	Food Waste Management (FWM)	Food Operations Efficiency (FOE)	
1	Mean	Mean	4.11	4.24	4.26	
		Std. Error	0.033	0.031	0.036	
		Level	High	Very High	Very High	
2	SD		0.778	0.724	0.855	
3	CV %		18.96	17.06	20.08	
4	Normality	Kolmogorov–Smirnov Test	0.141	0.147	0.192	
		Sig	0.000	0.000	0.000	
		Status	Non-Normal	Non-Normal	Non-Normal	
5	Validity	Kaiser-Meyer-Olkin Measure of Sampling Adequacy	0.867	0.929	0.871	
		Bartlett's Test of Sphericity	Approx. Chi-Square	2665.53	6234.17	2189.54
			Sig	0.000	0.000	0.000
6	Reliability	Cronbach's Alpha	0.917	0.953	0.931	
		No of Items	7	12	5	

The descriptive statistics for the research variables are displayed in Table (4). The findings showed that the standard deviation was 0.778 and the mean food operations sustainability (FOS) was 4.11 out of 5, which is regarded as a high level. Consequently, 18.96% is the coefficient of variance. Furthermore, food waste management (FWM) has a mean score of 4.24 out of 5 with a standard deviation of 0.724, which is regarded as an extremely high level. The result is a 17.06% coefficient of variance. Ultimately, the food operations efficiency (FOE) standard deviation is 0.855 and the mean is 4.26 out of 5, which is regarded as a very high level. The result is a 20.08% coefficient of variance. Furthermore, table (4) describes the Kolmogorov-Smirnov test-based normal distribution of study variables. Given that the significance level is 0.000, the study sample indicates that the data distribution for all research variables is non-normal. Furthermore, using the Kaiser-Meyer-Olkin measure of sample adequacy, the results showed that food operations efficiency (0.871), food waste management (0.929), and sustainability (0.867) are all statistically valid indicators of the data. Lastly, the data's Cronbach's Alpha test results for food operations efficiency (0.931), food waste management (0.953), and sustainability (0.917) indicate that the data is significantly reliable.

**Table (5): Descriptive Statistics of the Variables' Items**

No.	Statements	Mean		Std. Deviation	CV %	Level of Mean
		Statistic	Std. Error			
1	Hospitality establishment is looking for organic labels.	3.82	0.041	0.947	24.79	High
2	Hospitality establishment visits trade shows and farmers markets to discover new local suppliers.	4.25	0.036	0.851	20.02	Very high

3	Hospitality establishment meets its suppliers on a regular basis and builds strong relationships with them.	4.18	0.043	0.999	23.89	High
4	Hospitality establishment presents sustainable menus in an attractive way.	4.16	0.041	0.961	23.10	High
5	Hospitality establishment arranges the buffets so that more sustainable foods are available at the buffet center.	4.17	0.045	1.053	25.25	High
6	Hospitality establishment highlights organic produce and local regional foods on the name tags at the buffet.	4.06	0.044	1.025	25.24	High
7	Hospitality establishment offers many vegetarian alternatives in an attractive way.	4.10	0.034	0.805	19.63	High
<b>Food Operations Sustainability (FOS)</b>		4.11	0.03	0.78	18.95	High
1	Hospitality establishment is improving its menus to ensure cross-use of the same ingredients in different dishes.	4.34	0.033	0.766	17.64	Very High
2	Hospitality establishment establishes good purchasing procedures based on good inventory control and forecasting using tools such as inventory control and purchase list.	4.35	0.034	0.801	18.41	Very High
3	Hospitality establishment prepares items such as bread, cakes, and desserts, so it can control portions daily.	4.37	0.032	0.758	17.34	Very High
4	Hospitality establishment uses cutting tools creatively to prepare dishes or food items.	4.23	0.037	0.858	20.28	Very High
5	Hospitality establishment offers a special dish of the day to use up stock that is approaching its expiration date.	4.16	0.038	0.881	21.17	High
6	Hospitality establishment has methods in place to prevent waste on the buffet and on customer plates.	4.24	0.040	0.929	21.91	Very High
7	Hospitality establishment uses only functional and edible decorations to avoid wasting unnecessary dishes.	4.22	0.039	0.918	21.75	Very High
8	Hospitality establishment provides as many live cooking stations as possible at buffets to reduce food waste.	4.27	0.037	0.859	20.11	Very High
9	Hospitality establishment offers different sizes of food items to suit different tastes of customers.	4.21	0.044	1.028	24.41	Very High
10	Hospitality establishment avoids purchasing products that are overly packaged by, for example, using a large amount of plastic.	4.11	0.042	0.993	24.16	High
11	Hospitality establishment is reviewing and utilizing the recycling services provided in its area.	4.18	0.042	0.977	23.37	High
12	Hospitality establishment gives customers the opportunity to provide feedback about issues associated with certain types of meals.	4.21	0.038	0.890	21.14	Very High
<b>Food Waste Management (FWM)</b>		4.24	1.030	0.72	17.06	Very High
1	Hospitality establishment offers continuing education and trains employees in sustainable food operations.	4.44	0.038	0.893	20.11	Very High
2	Hospitality establishment works to establish long-term relationships with its suppliers.	4.23	0.041	0.958	22.64	Very High

3	Hospitality establishment includes a sustainable food policy in its vision and mission statement.	4.13	0.042	0.970	23.48	High
4	Hospitality establishment has an action plan to introduce a more sustainable food policy step by step.	4.21	0.044	1.023	24.29	Very High
5	Hospitality establishment provides fair working conditions for all employees.	4.27	0.042	0.983	23.02	Very High
<b>Food Operations Efficiency (FOE)</b>		4.26	0.037	0.85	20.08	Very High

The descriptive statistics of the variables' items are shown in Table (5). All of the categories for food operations efficiency, sustainability, and waste management vary from high to very high levels.

### Correlation Analysis

**Table (6): Correlation Analysis Between the Research Variables**

No.	Variable		R	Sig.	Correlation Type
	Independent Variable	Dependent Variable			
1	Food Operations Sustainability (FOS)	Food Waste Management (FWM)	0.650**	0.000	Moderate Positive Correlation
		Food Operations Efficiency (FOE)	0.616**	0.000	
2	Food Waste Management (FWM)	Food Operations Efficiency (FOE)	0.806**	0.000	High Positive Correlation

\*\*Correlation is significant at the 0.01 level (2-tailed) using Spearman correlation

The Spearman coefficient correlations between the research's variables are displayed in Table (6). The findings showed that, at the 0.01 level, there is a significantly high positive correlation ( $r = 0.806$ ; Sig. 0.000) between food waste management and food operations efficiency. Furthermore, food waste management ( $r = 0.650$ , Sig.0.000) and food operations efficiency ( $r = 0.616$ , Sig.0.000) have a moderately positive correlation with food operations sustainability.

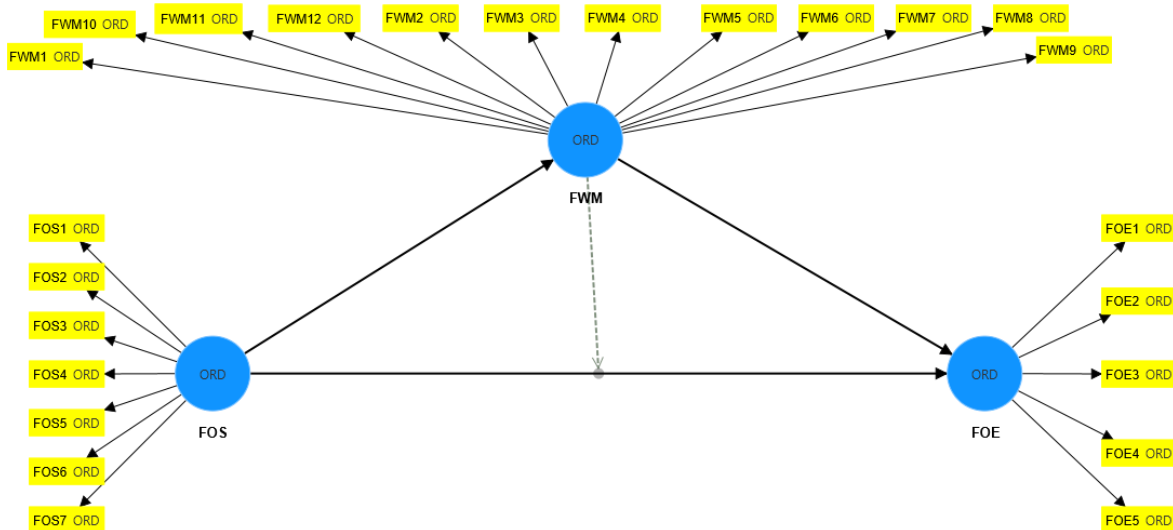
### Regression Analysis

**Table (7): The Regression Analysis between Research Variables**

Variables		Statistics						
Independent Variable	Dependent Variable	R	R <sup>2</sup>	Adjusted R Square	Standardized Coefficients Beta	a	b	Sig.
Food Operations Sustainability (FOS)	Food Operations Efficiency (FOE)	0.586	0.344	0.343	0.586	1.612	0.644	0.000
Food Operations Sustainability (FOS)	Food Waste Management (FWM)	0.699	0.489	0.488	0.699	1.572	0.650	0.000
Food Waste Management (FWM)	Food Operations Efficiency (FOE)	0.780	0.608	0.607	0.780	0.349	0.921	0.000

## Measurement Model

The relationships between the indicators (items) and the latent variables that these indicators measure, as well as the anticipated relationship between these variables, are depicted by the measurement model in Figure (2). Next, it displays the anticipated correlation between the dependent variable (food operations efficiency), and the independent variable (food operations sustainability). Finally, food waste management is entered as a moderate variable that may affect this relationship.



**Figure (2): The Measurement Model**  
Source: Outputs of SmartPLS Software

The researcher utilized factor loadings, composite reliability, and average variance extracted (AVE) to make sure the items meet appropriate convergent and discriminant validity and that the indicators represent their latent variables. After conducting this test, the researcher eliminated 28 items that did not satisfy the necessary standards from the food operations efficiency, 4 items from the food waste management, and 4 items from the food operations sustainability. The remaining components met the requirements. The converging credibility indicators are listed in Table (8).

**Table (8): Convergent Validity**

Variables	Item indicators	Type of Measure	Item loadings (Weights)	Composite Reliability (CR)		Cronbach Alpha	Average Variance Extracted AVE
				(rho_a)	(rho_c)		
Food Operations Sustainability (FOS)	FOS1	Reflective	0.825	0.918	0.933	0.916	0.665
	FOS2		0.796				
	FOS3		0.826				
	FOS4		0.848				
	FOS5		0.807				
	FOS6		0.840				
	FOS7		0.764				
Food Waste Management (FWM)	FWM1	Reflective	0.767	0.954	0.959	0.953	0.660
	FWM2		0.793				
	FWM3		0.821				
	FWM4		0.831				
	FWM5		0.841				

	FWM6		0.849				
	FWM7		0.772				
	FWM8		0.845				
	FWM9		0.733				
	FWM10		0.792				
	FWM11		0.855				
	FWM12		0.840				
Food Operations Efficiency (FOE)	FOE1	Reflective	0.861	0.935	0.948	0.931	0.783
	FOE2		0.886				
	FOE3		0.886				
	FOE4		0.903				
	FOE5		0.888				

Source: Outputs of statistical analysis using Smart PLS software

Table (8) demonstrates that all of the reflecting index loads were higher than the required cutoff level of 0.60 when all removed items from research scales were excluded. For every reflective combination, the composite reliability values surpassed the suggested threshold value of 0.70, and AVEs is higher than the recommended value of 0.50. Given that the Cronbach alpha values fall between 0.45 and 0.98, they are considered suitable. These indications suggest that the affinity has been validated. The discriminant validity is shown in the following table (9).

**Table (9): The Discriminant Validity**

Variables	FOE	FOS	FWM
Food Operations Efficiency (FOE)	0.885	-	-
Food Operations Sustainability (FOS)	0.603	0.816	-
Food Waste Management (FWM)	0.782	0.709	0.813

Source: Outputs of Statistical Analysis Using Smart PLS Software

Table (9) displays the discriminant validity-Fornell criterion in discriminant analysis to assess the degree of variance among the several compositional measures. The findings showed that the non-diagonal elements in the corresponding row and column were always smaller than the values in the diagonals of the matrix reflecting the square root of AVEs. This indicates that each variable has a higher connection with itself than it does with the other research variables. This confirms the discriminatory validity's fulfillment.

### Goodness of Fit (GoF) of the Model

The geometric mean of the AVE and the average R<sup>2</sup> of the endogenous variables is called Goodness of Fit (GoF). The goal of the GoF is to consider the overall performance of the model as well as the computation and structural model of the research. The following is the GoF calculating formula:

$$GoF = \sqrt[2]{(R^2 \times AVE)}$$

Based on the GoF criteria (below 0.1 = no fit, from 0.1 to 0.25 = small fit, from 0.25 to 0.36 = medium fit, and greater than 0.36 = large fit), the validity of the PLS model is determined. The GoF for this study was (0.697), indicating that the model was large enough to provide adequate global PLS model validity.

## Structural Model

An examination of the model's assumed relationship between exogenous and endogenous variables is part of the structural model. The regression result and path coefficient for the structural model are summarized in Table (10).

**Table (10): Structural Model's Path Coefficient and Regression Result**

Hypotheses	Relationship	Std. Beta	Std. Deviation	t-Value	p-Value	Decision
H1	FOS->FOE	0.121	0.049	2.456	0.014	Accepted
H2	FOS-> FWM	0.709	0.034	21.029	0.000	Accepted
H3	FWM->FOE	0.721	0.048	15.026	0.000	Accepted
H4	FWM×FOS->FOE	0.027	0.023	1.159	0.247	Rejected

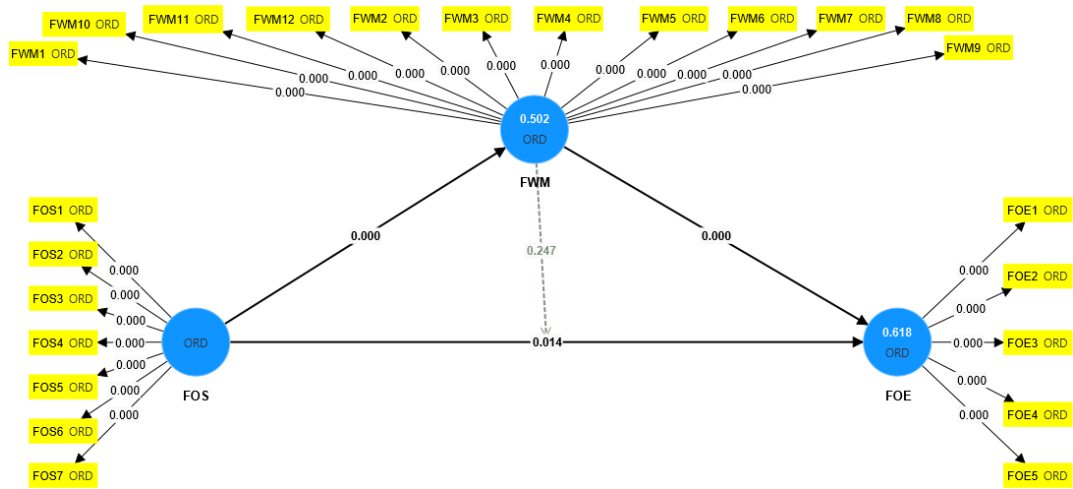
Table (10) displays the results of path coefficient and regression for the structural model. In detail, there was a positive relationship between food operations sustainability and food operations efficiency in five-star hotels in greater Cairo (Std. Beta 0.121 ; p-value 0.014). This indicates that the first hypothesis is accepted. In addition, there was a positive relationship between food operations sustainability and food waste management (Std. Beta 0.709; p-value 0.000). This means that the second hypothesis is also accepted. Moreover, there was a positive relationship between food waste management and food operation efficiency (Std. Beta 0.721; p-value 0.000). This means that the third hypothesis is accepted. Finally, the results revealed that food waste management doesn't moderate the relationship between food operations sustainability and food operations efficiency (Std. Beta 0.027; p-value 0.247). This means that the fourth hypothesis is rejected. The following table (11) displays the assessment of effect size ( $f^2$ ) for research variables.

**Table (11): Assessment of Effect Size ( $F^2$ )**

Constructs Relation	$f^2$	Result
FOS->FOE	0.017	Small Effect
FOS-> FWM	1.00	High Effect
FWM->FOE	0.66	High Effect
FWM×FOS->FOE	0.004	Small Effect

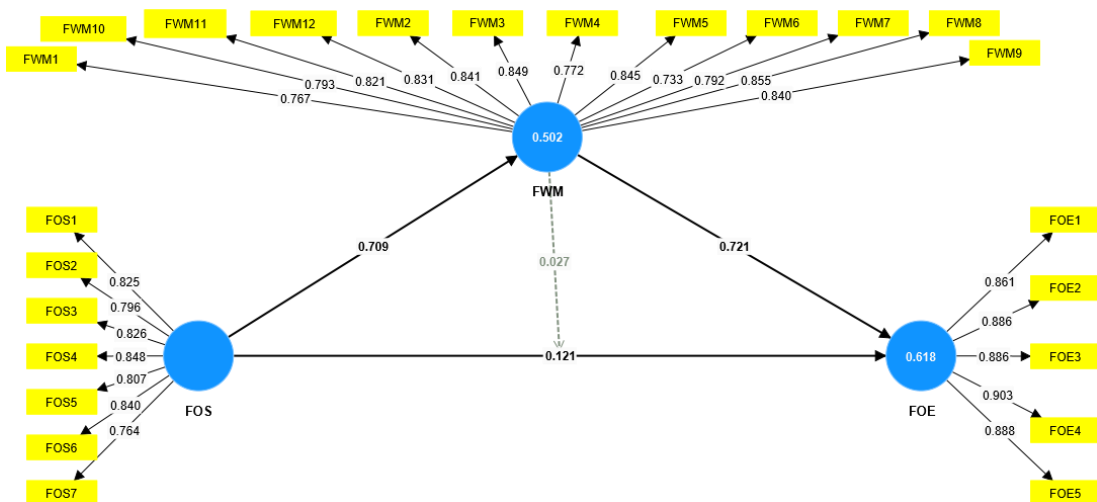
Source: Outputs of statistical analysis using Smart PLS software.

The effect size ( $f^2$ ) as shown in table (11) was calculated by the researcher to examine the impact of food operations sustainability and food waste management on food operations efficiency, as well as the impact of food waste management as a moderating variable on the relationship between these two variables. The food operations efficiency has a small effect (0.017) on the food operations efficiency. Furthermore, the food operations sustainability (1.00) has a high effect on the food waste management. Additionally, the food waste management (0.66) has a high effect on the food operations efficiency; the food waste management has a small effect on the size of the relationship between food operations sustainability and food operations efficiency. To test the statistical significance of PLS-SEM results, such as path coefficient, outer weights, Cronbach's alpha, HTMT, and R2, one nonparametric method that can be utilized is bootstrapping. Because the model is significant, as indicated by Figure (3), the researcher tested the PLS-SEM results for statistical significance.



**Figure (3): The Statistical Significance of PLS-SEM Results Using Bootstrapping**  
 Source: Outputs of Statistical Analysis Using Smart PLS

Based on the analysis and the results of this research, figure (4) shows this research's final structural model.



**Figure (4): The Research's Final Structural Model.**  
 Source: Outputs of Statistical Analysis Using Smart PLS

## Discussion and Implications

### Discussion

This research aims to investigate the relationships among food operations efficiency, food waste management, and food operations sustainability in five-star hotels in the greater Cairo area. About 564 respondents from the food and beverage department provided data for the research, which was then analyzed using component-based structural equation modeling (SEM) using the Smart PLS 4.1.0.0 software. The primary findings of this research are described below. First, the findings indicated that food operations sustainability (FOS) and food operations efficiency (FOE) has a moderate positive relationship. This outcome validates the first hypothesis' accuracy. Furthermore, it is highly persuasive because the individuals who demonstrated a high level of food operations efficiency also shown a high level of food operations sustainability. Furthermore, this conclusion supported earlier research findings that suggested a relationship existed between food operations efficiency (FOE) and food operations sustainability (FOS). According to literature review,

customers are more likely to patronize enterprises that practice social responsibility or employ green practices when making purchases of products and services (Lucas & Wilson, 2008; Yan & Yazdanifard, 2014; Ting *et al.*, 2019; Chung, 2020; Kim & Hall, 2020; T.M. *et al.*, 2021). According to several studies (Jeng & Yeh, 2015; Jang *et al.*, 2015; Bacig & Young, 2019), customers are more likely to frequent green establishments, be willing to pay more for environmentally friendly products and services (TM *et al.*, 2021; Rondoni & Grasso, 2021), and to stay at eco-friendly hotels. Moreover, hotels can improve their overall performance by incorporating sustainable practices (Langgat *et al.*, 2023).

According to Jang *et al.*, (2015), hospitality firms can gain a competitive advantage by adopting and endorsing green and corporate social responsibility (CSR) initiatives. In the hotel industry, sustainability is becoming more and more significant. It enhances the sustainability of its products and helps the hotel industry (Jacobs & Klosse, 2016). CSR is a common marketing strategy used by hospitality businesses to attract customers and cultivate a favorable reputation (Nguyen & Chiu, 2023). More efficient waste management is crucial to lowering the quantity of waste produced by the hospitality sector, even if increasing the effectiveness of the use of supplies and raw materials directly influences the performance of enterprises (Pirani & Arafat, 2014; Duric & Topler, 2021). The bad practices in the hotel sector, like subpar construction, subpar customer service, and subpar maintenance design, will have a negative impact on the environment. The efficiency of hotel operations is impacted by green practice implementation, sustainable expansion, and effective management (Prakash *et al.*, 2023).

Second, the findings demonstrated a moderate positive relationship between food waste management (FWM) and food operations sustainability (FOS). Thus, it can be concluded that the second hypothesis is accepted. Therefore, the level of food waste management increases with the level of food operations sustainability. This result is matched with the literature review, as food waste has become a major problem (Tostivint *et al.*, 2016). It stems from issues that are both operational and nonoperational (Wang *et al.*, 2017; Dolnicar & Juvan, 2019; Silvennoinen *et al.*, 2015). Moreover, meal planning and overproduction-related food waste could be reduced with the implementation of a pre-ordering meal system (Lorenz *et al.*, 2020). Finally, the main factor influencing the adoption of sustainable practices is waste management (Arici *et al.* 2023). Third, the findings demonstrated a high positive relationship between food operations efficiency (FOE) and food waste management (FWM). This indicates that the third hypothesis is accepted. Therefore, the efficiency of food operations increases with the degree of food waste management. This result is matched with the literature review, as the entire performance of hotels was impacted by waste management strategies (Arici *et al.*, 2023). Lastly, food waste management does not moderate the relationship between food operations sustainability and food operations efficiency (Std. Beta 0.027; P-value 0.247). As a result, the fourth hypothesis is rejected.

### **Implications**

In the hospitality industry, sustainability is a major issue that management needs to handle effectively. The research's findings indicate that putting sustainable food operations techniques into practice results in both efficient food operations and successful food waste management. In addition, this process saves money, and time, and might enhance revenues for hospitality enterprises. Moreover, effective food operations are a result of minimizing food waste. To secure the success of the complete operating system, this last point urges hospitality organizations to implement excellent sustainability standards in food and beverage operations.

### **Conclusion**

Today, the issue of sustainability is considered one of the important global trends, due to climate changes and the economic crises that dominate the world. So, hospitality organizations seek to the sustainable development in their operations to create a competitive advantage. This sustainable development requires an integrated approach that takes into consideration environmental concerns



along with economic development. Consequently, the primary aim of this research was to model the relationships among food operations sustainability, food waste management, and food operations efficiency in five-star hotels in greater Cairo. The methodology of this research is descriptive/analytic, and the population included the staff of food and beverage department whether managers or employees in five-star hotels in greater Cairo. Therefore, this research was based on the method of random stratified sample. First, the results showed that there was a moderate positive relationship between the food operations sustainability (FOS) and the food operations efficiency (FOE). It also is very convincing in that the participants who had a high level of food operations sustainability, they had a high level of food operations efficiency. Second, the results showed that there was a moderate positive relationship between the food operations sustainability (FOS) and the food waste management (FWM). Thus, the greater the level of the food operations sustainability; the greater the food waste management. Third, the results showed that there was a high positive relationship between the food waste management (FWM) and the food operations efficiency (FOE). Thus, the greater the level of the food waste management; the greater the food operations efficiency. Fourth, the results revealed that the food waste management do not moderate the relationship between the food operations sustainability and the food operations efficiency since the p-value was (0.247). Practically, sustainability is a principal issue in the hospitality industry that managers must deal with professionally. According to the results of this research, implementing the practices of sustainable food operations leads to efficient food operations, and leads to effective food waste management. Moreover, managing food waste leads to efficient food operations. Finally, this calls on hospitality establishments to adopt outstanding sustainability practices in food and beverage operations to ensure the success of the entire operating system.

### **Recommendations**

The following actions should be taken by hospitality establishments to improve food and beverage management in light of the research's findings. Hospitality managers should

- Look for organic labels.
- Visit trade shows and farmers markets to discover new local suppliers.
- Meet its suppliers regularly and build strong relationships with them.
- Attractively present sustainable menus.
- Arrange the buffets so that more sustainable foods are available at the buffet center.
- Highlight organic produce and local regional foods on the name tags at the buffet.
- Offer many vegetarian alternatives attractively.
- Improve its menus to ensure cross-use of the same ingredients in different dishes.
- Establish good purchasing procedures based on good inventory control and forecasting using tools such as inventory control and purchase lists.
- Prepare items such as bread, cakes, and desserts, so it can control portions daily .
- Use cutting tools creatively to prepare dishes or food items.
- Offer a special dish of the day to use up stock that is approaching its expiration date.
- Have methods in place to prevent waste on the buffet and customer plates.
- Use only functional and edible decorations to avoid wasting unnecessary dishes.
- Provide as many live cooking stations as possible at buffets to reduce food waste.
- Offer different sizes of food items to suit different tastes of customers.
- Avoid purchasing products that are overly packaged by, for example, using a large amount of plastic.
- Review and utilize the recycling services provided in its area.
- Allow customers to provide feedback about issues associated with certain types of meals.

- Offer continuing education and train employees in sustainable food operations.
- Work to establish long-term relationships with its suppliers.
- Include a sustainable food policy in its vision and mission statement.
- Have an action plan to introduce a more sustainable food policy step by step.
- Provide fair working conditions for all employees.

### Limitations and Future Research

The five-star hotels in the Greater Cairo area were the focus of this study. Hospitality researchers might investigate the relationships among the research variables in various locations and hotel classifications for the next studies.

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## تأثير استدامة عمليات الأغذية على كفاءة عمليات الأغذية: الدور الوسيط لإدارة هدر الطعام في فنادق الخمس نجوم بالقاهرة الكبرى

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يهدف هذا البحث إلى دراسة العلاقات بين استدامة عمليات الأغذية، وإدارة هدر الطعام، وكفاءة عمليات الأغذية. لذلك فإن المنهج يعتبر تحليلي، ومجتمع هذا البحث يتضمن المديرين والعاملون بفنادق الخمس نجوم بمنطقة القاهرة الكبرى، والعينة طبقية عشوائية. ونتيجة لذلك، حصل الباحث على معلومات من 564 مشاركاً من قسم الأغذية والمشروبات. وقد تم تحليل البيانات من قبل الباحث باستخدام نمذجة المعادلات الهيكلية (SEM) بواسطة برنامج (SmartPLS 4.1.0.0). لقد كشف هذا البحث أن هناك علاقة إيجابية عالية بين إدارة هدر الطعام (FWM) وكفاءة عمليات الأغذية (FOE)؛ وعلاقة إيجابية معتدلة بين استدامة عمليات الأغذية (FOS) وإدارة هدر الطعام (FWM)؛ وعلاقة إيجابية معتدلة بين استدامة عمليات الأغذية وكفاءة عمليات الأغذية. علاوة على ذلك، أظهر هذا البحث أن العلاقة بين استدامة عمليات الأغذية وكفاءة عمليات الأغذية لا يتم التحكم فيها من خلال إدارة هدر الطعام. وأخيراً، يجب على المديرين بصناعة الضيافة تنفيذ أفضل ممارسات عمليات الأغذية المستدامة لتحسين إدارة هدر الطعام وكفاءة عمليات الأغذية.

**الكلمات المفتاحية:** استدامة عمليات الأغذية؛ إدارة هدر الطعام؛ كفاءة عمليات الأغذية؛ فنادق الخمس نجوم.