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Determinants and effects of food waste in restaurants: A systematic literature review

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ABSTRACT

Food Loss and Waste (FLW) has primarily focused on quantifying causes. This article organizes literature on FLW determinants and effects in restaurants, analyzing 80 articles from Scopus and Web of Science. Findings reveal FLW in restaurants, which is determined by consumer behavior, restaurant management, and public policies, has economic and environmental effects. The study emphasizes the importance of investing in employee training and policies promoting FLW reduction. It also underscores the need for educating consumers on responsible consumption. Implementing these measures will contribute to fostering sustainable and efficient food systems, minimizing the adverse effects of food waste.

Keywords: Food loss and waste; FLW; restaurants; systematic literature review.

1 Introduction

It is estimated that one-third of the world's food produced for human consumption is lost or wasted (FAO et al., 2019). One of the United Nations' goals is, by 2030, to "halve global per capita retail and consumer food waste, as well as food losses along production and supply chains, including post-harvest losses and consumer waste" (Johnston, 2016).

In an era of growing environmental consciousness, both professionals and academics show considerable interest in the subject of food waste (Meixner et al., 2020). The topic of reducing Food Loss and Waste (FLW) has been extensively researched, often with a focus on specific aspects such as the quantification and causes of waste. However, there has been relatively little discussion on the determinants and practices implemented to reduce FLW (de Moraes et al., 2020).

Annually, European countries produce around 88 million tons of food waste, of which 12%, or 11 million tons, is attributed to the food service sector (Stenmarck et al., 2016). A significant contributor to food waste in this sector is the leftover food from consumers in restaurants and cafés (Parfitt et al., 2013). A study conducted in the UK reported that 30% of the food waste generated in restaurants is attributed to plate waste (SRA, 2010). According to Thyberg and Tonjes (2016), making restaurants and food systems more sustainable is essential and urgent; actions across food systems are needed to moderate demand, produce more food, improve governance, and reduce food waste. Therefore, it is imperative to identify the determinants that contribute to FLW in the restaurant sector.

This underscores the significance of systematically organizing and analyzing global scientific research on FLW in restaurants. This analysis should identify both the determining factors and the effects of such waste. In doing so, this research not only contributes to the existing literature on the subject but also offers valuable insights for public policymakers and individuals responsible for restaurant management.

To attain the objective of mapping research on FLW in restaurants, along with its determinants and effects, this study addressed the following guiding questions: (1) What are the characteristics of the existing body of scientific research globally on FLW in restaurants? (2) What are the determinants and effects of food waste in restaurants? To achieve this, a systematic review of the literature was conducted using the Scopus and Web of Science databases, yielding 80 papers published between 2014 and 2023.

The main contributions of this article consist of organizing and summarizing the previous literature within the scope of FLW determinants and effects, considering the idiosyncrasies embedded in the foodservice context.

Furthermore, the authors propose a conceptual model that explicates the main determinants and effects of FLW in the restaurant environment. Finally, we propose a call to action to empower restaurant owners and managers to devise proper solutions to mitigate FLW that might be applied in different serving formats.

The structure of the remaining sections in this article is as follows: Section 2 outlines the methodology employed for data collection and analysis. Section 3 presents the results obtained, while Section 4 provides a discussion. Finally, in Section 5, the article concludes with a summary, outlines the limitations of the study, and offers suggestions for future research.

2 Method

A systematic review of the literature was conducted following the PRISMA 2020 guideline, which "provides guidelines [...] for systematic reviews, which reflect advances in methods for identifying, selecting, evaluating and synthesizing studies" (Page et al., 2021). It is necessary to transparently describe the review design process and the literature collection method (Snyder, 2019). Therefore, defining a clear protocol for the article selection process is essential. Tranfield et al. (2003) highlight that the protocol defined before the start of the review process establishes the search strategy, the inclusion and exclusion criteria for studies, and the description of the methods to be used. The step-by-step process used in this research is presented in Table 1.

2.1 Definition of databases

Scopus and Web of Science databases were chosen for their comprehensive coverage and rigorous article indexing criteria, making them ideal for identifying relevant academic research. Webster and Watson (2002) emphasize that a thorough review must encompass relevant literature on the topic and cannot be limited to specific scientific journals.

Table 1.
Systematic Review Protocol.

1. Mapping the field through a scoping review
Objective
Map research on FLW in restaurants, along with its determinants and effects
Research Questions
a) What are the characteristics of the existing body of scientific research globally on FLW in restaurants?
b) What are the determinants and effects of food waste in restaurants?
2. Methodology
Search Terms:
("food wast*" OR "food los*" OR "FLW") AND ("restaurant*") AND ("practice*" OR "polic*" OR "mitig*" OR "initiav*")
Included Databases:
Scopus, Web of Science (WoS)
Study Criteria:
Inclusion Criteria
IC1: Articles published in Academic Journals
IC2: Peer-reviewed journals
IC3: Publication on the topic of FLW in restaurants
IC4: Publication years between 2014 and 2023
IC5: Any language as publication language
Exclusion criteria
EC1: Conference papers or book chapters
EC2: Non-peer-reviewed Journals and grey literature
EC3: Publication years before 2014
3. Quality Assessment
Assess the relevance of the studies concerned to answering the research question
4. Results
Report data obtained in the previous stage
5. Discussion
Summarize the main findings including the strength of evidence for each main outcome
6. Limitations
Highlight the limitations and any possible gaps to overcome
7. Conclusions
Provide a general interpretation of the results in the context of other evidence, and implications for future research

2.2   Research and data collection strategy

For Paul and Criado (2020), the definition of keywords used in the research strategy must be carried out according to the researcher's knowledge, judgment, and experience. The terms were defined after reading articles that addressed the topic.

In this research, the terms "food waste" and "food loss" were used to identify articles addressing these themes. For this survey, any of the terms were considered valid and the search string used was ("food wast*" OR "food loss* OR "FLW"). The use of the asterisk is so that variations of the terms, such as "food waste" or "food wasting", are considered, thus allowing for broader coverage. To delimit articles that specifically referred to the practices and initiatives adopted to mitigate FLW, the same strategy was followed, using the string ("practic*" OR "polic*" OR "mitig*" OR "initiav*"). Additionally, the selection was delimited with the string ("restaurant*"), selecting only articles containing the term "restaurant" and its variants, which aligns with the focus of this study. All terms were searched in the title, abstract, and keywords fields, as these sections contain the main terms of the articles.

The selected period for research encompassed publications from 2014 to 2023, covering a span of 10 years, which is considered appropriate for the analysis of publications on a specific topic (Vouga and Amatucci, 2015). The search was limited to articles published in scientific journals, excluding, for instance, conference papers, as the former generally adhere to higher quality standards for publication acceptance (Salazar-Moya and Garcia, 2021).

Thus, the complete search string adopted was (TITLE-ABS-KEY ("food wast*" OR "food los*" OR "FLW") AND TITLE-ABS-KEY ("restaurant*") AND TITLE-ABS- KEY ("practice*" OR "polic*" OR "mitig*" OR "initiav*")) AND PUBYEAR > 2013 AND PUBYEAR < 2024 AND (LIMIT-TO (SRCTYPE, "j")), which brought, in survey carried out on January 04, 2024, a total of 151 publications in the Scopus database and 183 in the Web of Science that met all criteria, as shown in Figure 1.
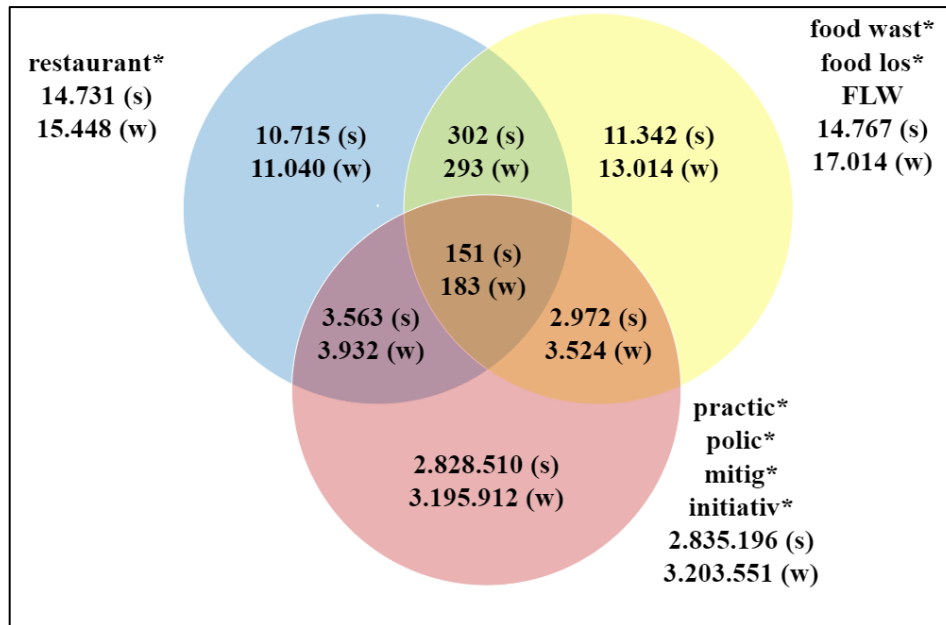
Figure 1. Number of Studies by Selection Criteria
(s: Scopus database; w: Web of Science database)

2.3 Data storage and processing

All selected articles were downloaded and added to the Mendeley tool, considered good practice to facilitate data processing (García-Peñalvo, 2022).

The first step involved removing duplicate searches between the two databases (n = 113) and excluding non-scientific articles (n = 31). Subsequently, the titles and abstracts of all articles were reviewed to screen for relevance to the study's topic, eliminating articles that did not align with the objective at this stage (n = 92). Following Snyder's (2019) recommendation, the titles and abstracts were initially reviewed for a preliminary selection, and then the full articles were read to make the final selection. The resulting articles were read in full, and those not adhering to the theme were excluded in a floating manner (n = 7).

After completing all the steps, as illustrated in Figure 2, a final selection of 80 valid articles was obtained for this systematic review.

2.4 Data analysis and interpretation

To achieve the objectives of this research, the selected articles were imported into the Atlas.ti tool for analysis. According to Lewis (2017), Atlas.ti provides significant assistance in systematic reviews for coding themes, determining how studies are related, and synthesizing results.

3 Results

This section provides a synthesis of the main characteristics of the selected articles obtained in the systematic literature review.

3.1 Descriptive analysis

An upward trend is observed in the number of articles published over the years, with a notable drop in the year 2022, the number of which remained consistent in the following year (Figure 3). In 2020 and 2021, restaurants faced in-person operating restrictions due to the COVID-19 pandemic, which may have impacted the publication of studies on FLW in these establishments. Conversely, an increase is observed in articles published about the effects of these restrictions on restaurants (Bhoola, 2022; Karniouchina et al., 2022; Thoha et al., 2022).
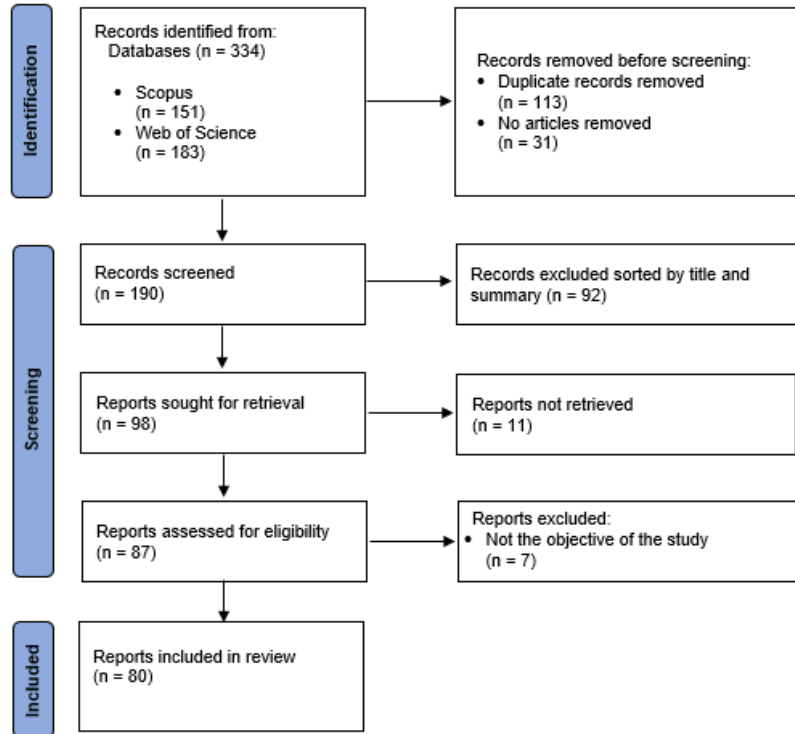
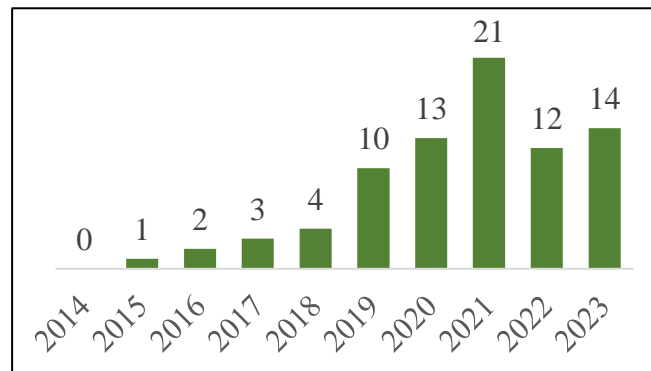**Figure 2**. Flowchart of the Research Steps.

Figure 3. Publications per Year

The 80 selected studies found publication in 48 journals, as delineated in Table 2. Although the subject matter has been disseminated across various journals, each journal published an average of less than two articles on the topic in the last 10 years. This indicates that there is room for the topic to garner increased attention and research publications in the future.

A total of 351 keywords were used by the authors (Figure 4), with the most common being "food waste" (47), "restaurant(s)" (16), "sustainability" (7), "mitigation" (6), "consumer behavior" (4), and "environmental impact" (4). Notably, "sustainability," "environmental impact," and "consumer behavior" were not initially included in the database search terms, indicating their relevance as emerging themes.

3.2   Analytical analysis

To better understand the relationships between articles, VOSviewer software was used to analyze the keywords, as illustrated in Figure 5.

Table 2.
Publications by Periodical

| Periodical	Number
Journal of Cleaner Production	9
Sustainability (Switzerland)	8
British Food Journal	6
Waste Management	5
International Journal of Hospitality Management	4
Sustainability	3
International Journal on Food System Dynamics	2
Sustainable Production and Consumption	2
Tourism Management Perspectives	2
Other journals (one publication each)	39
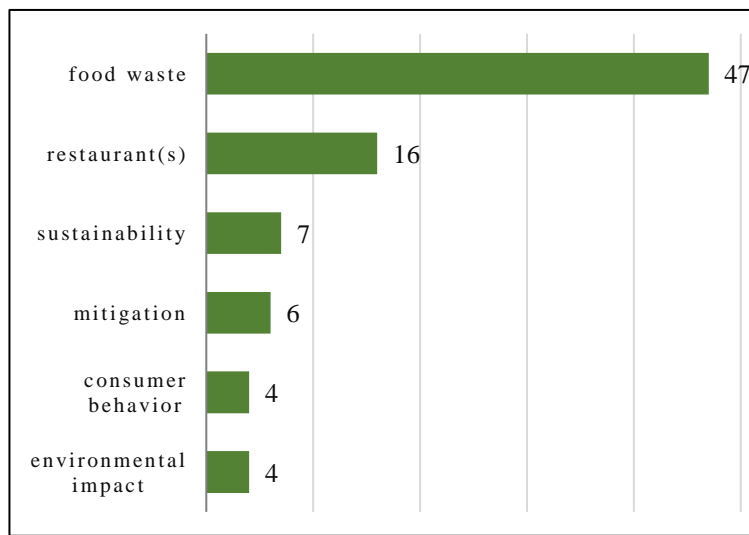
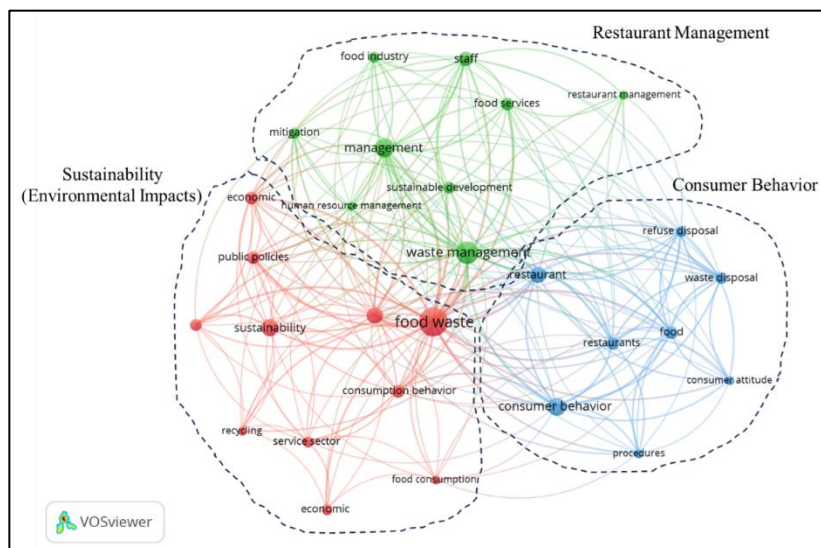**Figure 4.** Most Used Keywords

Figure 5– VOSviewer Clusters Map

Through the analysis, three main clusters were identified with some intersections between them, as classified by the author: Restaurant Management, Consumer Behavior, and Sustainability. These clusters served as the initial reference points in the coding process of the articles. However, during a detailed examination of each selected article, additional recurring themes were identified and subsequently coded: Public Policies and Economic Analysis.

Sustainability is a concept that encompasses economic, social, and environmental aspects (Ruggerio, 2021). An examination of the content of articles within the cluster initially categorized as Sustainability revealed that all articles focused on the environmental aspect. Finally, we have arrived at the key topics addressed in the literature, as outlined in Table 3.

Table 3.
Articles on Determinants and Effects of FLW in Restaurants

Topic	Nº.		Articles
Restaurant management	27		Akamatsu et al. (2022); Alcorn et al. (2021); Auwalin et al. (2022); Berkowitz et al. (2016); Bharucha (2018); Cozzio, Tokarchuk, and Maurer (2021); Deliberador, César, and Batalha (2021); Filimonau et al. (2022); Filimonau, V. et al. (2023); Filimonau, Krivcova, and Pettit (2019); Filimonau, Zhang, and Wang (2020); Hennchen (2019); Ko and Hong, (2023); Lemos and De Paula Castro (2021); Martin-Rios, Demen, and Pasamar (2022); Maschio, et al. (2023); Mcadams et al. (2021); Montesdeoca-Calderon, Gil-Saura and Ruiz-Molina (2020); Nasser et al. (2021); Okumus et al. (2020); Rodriguez-Rodriguez et al. (2021); Sha'ari et al. (2023); Silvennoinen, Nisonen and Pietiläinen (2019); Stirnimann and Zizka (2022); Tagliabue and Sandaker (2019); Wu and Teng (2022); Zeineddine et al. (2021)
Consumer behavior	26		Antonschmidt and Lund-Durlacher (2021) ; Camilleri-Fenech et al. (2020); Çavuş, Bayhan, and Ismail (2022); Chen et al. (2024); Coskun and Filimonau (2021); Coşkun and Özbük (2020); Filimonau et al. (2020b); Filimonau, Nghiem, and Wang (2020); Hao et al. (2024); Huang and Tseng (2021); Kim, Che, and Jeong (2023) ; Long et al. (2024); Marx-Pienaar et al. (2020); Massuga et al. (2022); Matzembacher et al. (2020); Mumtaz et al. (2022); Papargyropoulou et al. (2016); Sun, Shahrajabian, and Cheng (2021); Tahir et al. (2023); Talwar et al.. (2021); Talwar et al. (2023a); Tatano et al. (2017); Wang et al. (2022); Yi-Chi, Lin and Hsiao (2022); Wu et al. (2023); Yu et al. (2021)
Environmental impacts	16		Baltescu et al. (2022); Buczacki, Gladysz and Palmer (2021); Bux and Amicarelli (2023); Camilleri (2021); Charlebois, Creedy and Von Massow (2015); Delgado and Staszewska (2023); Erälinna and Szymoniuk (2021); Filimonau et al. (2019); Filimonau et al.. (2020a); Filimonau and Ermolaev (2021); Filimonau and Sulyok (2021); Gladysz, Buczacki, and Haskins (2020); Gruia et al. (2021); Sakaguchi, Pak, and Potts (2018); Tehrani, Fulton, and Schmutz (2020); Zulkifli et al. (2019)
Public policies	6		Ai, Zheng (2019); Chalak, Abou-Daher and Abiad (2018); Dagiliute and Musteikyte (2019); Henz and Porpino (2017); Michalec et al. (2018); Reitemeier, Aheeyar and Drechsel (2021)
Economic analysis	4		Christ and Burritt (2017); Huiru et al. (2019); Lang et al. (2020); Papargyropoulou et al. (2019)

Based on the content of the articles, the main topics covered were (1) restaurant management, (2) consumer behavior, (3) environmental impacts, (4) public policies, and (5) economic analysis. Items (3) and (5) were treated as effects of FLW in restaurants, while (1) and (2) were considered as determining factors for FLW in restaurants, with public policies (4) acting as a moderator for restaurant management. Further discussion on this follows in the next section.

4   Discussion

According to the literature, it is possible to claim that FLW in restaurants has economic and environmental effects and depends on consumer behavior, as well as restaurant management, the latter being moderated by appropriate public policies. This relationship can be represented by the conceptual model proposed in Figure 6. A conceptual framework provides a visual representation of the essential components to be explored and the interconnections among them. Constructed upon prior theoretical insights and empirical research findings (Miles et al., 2014), it serves as a comprehensive guide for understanding the subject matter.
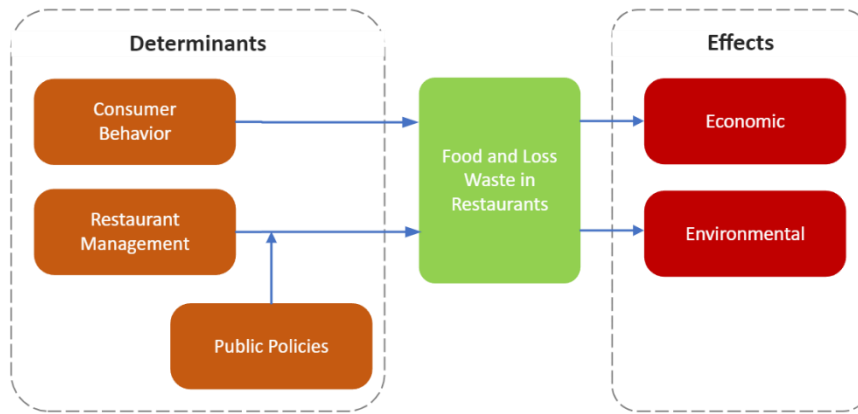
Figure 6. Determinants and Effects of FLW in Restaurants

4.1 Determinants of food waste

4.11 Consumer behavior

Part of food waste is due to consumer behavior. Irresponsible consumer behavior represents one of the key causes of food waste in restaurants (Filimonau et al., 2020b). Waste from consumers' dishes in restaurants is an important source of waste generated outside the home, with most of the food waste originating from the food service sector (Huang and Tseng, 2020). Çavuş, Bayhan, and Ismail (2022) concluded that while there is a level of consumer awareness regarding food waste, this awareness is not adequately translated into attitudes, behaviors, and practices.

The authors suggest that educating individuals about factors such as environmental degradation resulting from food waste, the impact on health, poverty, and hunger in various regions would be advantageous.

This highlights the importance of changing consumer behavior to reduce food waste in restaurants. It is necessary to promote consumer awareness about the importance of avoiding food waste and encouraging responsible consumption practices, such as ordering only what is necessary, taking leftovers home, and making the most of food consumed outside the home.

4.12 Restaurant management

Management also bears their share of responsibility. Lemos and De Paula Castro (2021) highlight that management influences food waste through operational violations resulting from unrecorded operations and administrative errors arising from discrepancies in controls and inventories caused by employee actions. Negligence and indifference of restaurant employees regarding waste were observed, and some incentives should be offered to minimize it (Bharucha, 2018).

Researchers Deliberador, da Silva César, and Batalha (2021) suggest regular training on correct preparation methods for restaurant employees, thus minimizing avoidable and potentially avoidable waste. Leadership needs to raise awareness among employees about the importance of avoiding food waste, from the moment of preparation to the proper disposal of leftovers. Additionally, incentives offered by management, such as recognition and rewards programs, can be implemented to motivate employees to actively engage in reducing FLW in restaurants.

4.13 Public policies

Public policies can be implemented to reduce food waste. Local governments play a key role in implementing effective strategies to minimize food waste in restaurants. As highlighted by Ai and Zheng (2019), public policies significantly influence the management of food waste by establishing regulations and guidelines for the handling of food waste in restaurants. This includes requiring the implementation of waste reduction strategies, proper food storage and handling, and the utilization of composting or recycling systems. Consequently, the approach a restaurant adopts in managing FLW will vary depending on the prevailing public policies. Moderation analysis is employed when interest is directed toward questions about the circumstances under which a certain variable influences another (Igartua and Hayes, 2021). In this context, public policies act as a moderating factor, influencing the relationship between restaurant management practices and the level of food waste generated.

One approach that could be implemented through public policies to address this issue is to offer free specialized training to restaurant managers and employees on how to mitigate food waste in kitchens (Filimonau, Zhang, and Wang, 2020). This may include proper techniques for storing, preparing, and managing leftovers. Furthermore, policies and

regulations can be implemented to advocate the development of voluntary and even mandatory strategies aimed at reducing and preventing food waste (Chalak, Abou-Daher, and Abiad, 2018). Public policies can also encourage collaboration and networking among restaurants, waste management agencies, and other stakeholders to share best practices, resources, and solutions for food waste management (Ai and Zheng, 2019).

4.2 Effects of food waste

4.21 *Economic effects*

Food waste represents a substantial economic loss of approximately 23% of the value of the food purchased, with the largest fraction of this loss occurring during the dish preparation process (Papargyropoulou et al., 2019). In addition to the direct economic effect, reducing FLW can result in savings for restaurants. The economic, environmental, and social effects of FLW are recognized at the highest levels of global governance (Papargyropoulou et al., 2019).

The acknowledgment of these effects emphasizes the economic significance of implementing comprehensive measures to address food waste. This not only underscores the environmental and social aspects but also highlights the potential economic gains achievable through the reduction of food waste, contributing to enhanced financial outcomes for businesses and economies on a global scale.

4.22 *Environmental impacts*

FLW has salient effects on environmental dimensions. Concerns about health, social, environmental, and ethical issues have become increasingly relevant worldwide (Erälinna and Szymoniuk, 2021). Food waste is recognized as a problem causing significant negative socioeconomic and environmental effects (Filimonau et al., 2020a). Waste from discarded food results in negative effects on the environment, contributing to the increase in greenhouse gas production, the degradation of natural resources, and the loss of biodiversity, among other problems (Camilleri, 2021).

Therefore, addressing the reduction of food waste emerges as a fundamental requirement to alleviate the adverse environmental effects associated with both food production and disposal. The collective body of research underscores the pressing need for coordinated efforts in comprehensively managing FLW. This necessity extends beyond environmental considerations, as it plays a significant role in mitigating broader socioeconomic concerns on a global scale.

5 Conclusions

This systematic literature review highlights the complex issue of food waste in restaurants, identifying key determinants and effects. Restaurant management practices, consumer behavior, and public policies all play a significant role in influencing the level of food waste generated. While the economic and environmental consequences of food waste are substantial, the research also points towards potential solutions through targeted interventions at various levels.

Food waste represents a substantial economic loss, so reducing FLW can result in savings for restaurants, highlighting the importance of implementing sustainable practices to minimize waste.

The environmental effects of FLW are increasingly recognized, as wasted food contributes to the production of greenhouse gases, degradation of natural resources, and loss of biodiversity.

Changing consumer behavior is key to reducing food waste in restaurants, as consumer dish waste is a major source of food waste outside the home. It is necessary to promote consumer awareness about the importance of avoiding food waste and encourage responsible consumption practices.

Restaurant management also plays a significant role in reducing food waste, as employee negligence and indifference can contribute to waste. Implementing regular training on correct preparation methods can minimize avoidable and potentially avoidable waste. Incentives, such as recognition and rewards programs, can also motivate employees to actively engage in reducing FLW in restaurants.

In addition to individual actions by consumers and restaurant managers, public policies play a fundamental role in reducing FLW. The government can implement strategies to minimize food waste in restaurants, including providing free specialized training for managers and employees on proper techniques for storing, preparing, and managing leftovers. Policies and regulations can also encourage sustainable practices, such as voluntary or mandatory programs to reduce and/or prevent food waste. Tax incentives for restaurants that implement sustainable practices may also be considered.

The limitation of the study lies in its sole use of the SCOPUS and Web of Science databases. To enhance the comprehensiveness of the research, it is recommended to address this limitation by extending the investigation to include other databases. For future research, qualitative studies are suggested to further deepen and understand each

of the determinants of food waste. Theoretical models explaining these determinants can also be established and validated through quantitative research.

This systematic literature review advances the understanding of food waste in restaurants by organizing topics related to FLW, exploring their determinants and effects, and providing insights from the literature on actionable measures to mitigate food waste.

Acknowledgments

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