Smart Food Waste Management: "Reducing Food Waste in Restaurants through Ubiquitous Computing"

Sridivya Kuncham, Masters in HCI at IUPUI, skuncham@iu.edu

Ishwarya Rajalaxmi Subramanian, Masters in HCI at IUPUI, irajalax@iu.edu

Adarsh Sai Rohan.Devineni, Masters in HCI at IUPUI, adadevi@iu.edu

Abstract

Food waste has negative impacts on economic and environmental aspects, as well as contributing to food insecurity globally. In the United States, restaurants account for 40% of food waste, with almost 85% of unused food being often wasted for various reasons, including not utilizing all parts of the food, food spoilage, errors made during cooking, customers leaving food on their plates, and dishes being returned when customers are dissatisfied (Business Insider). This paper proposes a technology-based solution in the form of a mobile application that connects restaurants with excess food to nearby community organizations such as food banks. The application scenario involves a restaurant user logging into the app to track their food waste and schedule a donation pickup with a nearby food bank, while a food bank user logs into the app to view available donations and schedule pickups. The research identifies key features of the application, including automated tracking of food waste and streamlined donation scheduling, which can significantly reduce food waste in restaurants and increase food donations to community organizations. The paper concludes with recommendations for the development and implementation of the mobile application, emphasizing the potential economic, social, and environmental benefits of reducing food waste and increasing food donations in the restaurant.

CCS Concepts: This paper includes Food Insecurity, Mobile Applications, Food Waste, Donation, Food Banks and Food Tracking

1. Introduction

Food waste is a growing global issue with significant economic, environmental, and social consequences (FAO, 2019). In the United States, restaurants are a major contributor to food waste, accounting for 40% of all food that is thrown away (ReFED, 2018). This waste occurs due to various reasons, including overproduction, spoilage, and customer leftovers (Gunders, 2012). In fact, a report by Business Insider (2018) found that almost 85% of unused food in American restaurants is discarded. This highlights the urgent need for innovative solutions to address the problem of food waste in the restaurant industry.

To address this issue, initiatives have been developed to reduce food waste, such as connecting surplus food from restaurants with community organizations in need (Second Harvest, 2021). Specifically, this paper focuses on a mobile app-based solution that can facilitate donations to food banks and other community organizations. The proposed application scenario involves a restaurant user logging into the app to track their food waste and schedule a donation pickup with a nearby food bank. On the other hand, a food bank user logs into the app to view available donations and schedule pickups.

This paper aims to explore the impact of technology on reducing food waste and supporting food-insecure populations, as well as the potential economic, social, and environmental benefits of using these tools. It proposes key features of the mobile application, including automated tracking of food waste and

streamlined donation scheduling, that can significantly reduce food waste in restaurants and increase food donations to community organizations.

The significance of this paper lies in its potential to reduce food waste and address food insecurity in local communities. By providing a platform for restaurants to donate their excess food, the mobile app can improve the efficiency of food recovery and reduce the amount of food that goes to waste. Moreover, the real-time notifications and pickup scheduling provided by the app can help community organizations respond more quickly and efficiently to the needs of their clients. The model of the app can also be applied to other industries and contexts where excess resources exist, making it a scalable solution to reducing waste and improving efficiency. Therefore, this paper proposes a comprehensive solution to the problem of food waste in the restaurant industry, which can have significant economic, social, and environmental benefits.

1.1 Scenario:

The proposed solution is a mobile app that connects restaurants with excess food to nearby community organizations, such as food banks, in order to reduce food waste and help alleviate food insecurity. The app offers features such as automated tracking of food waste and streamlined donation scheduling, making it easier for restaurants to donate their excess food and for community organizations to receive and distribute it to those in need.

The application scenario is as follows: a restaurant user logs into the app to track their food waste and schedule a donation pickup with a nearby food bank. The app's automated tracking feature allows the restaurant to easily monitor their excess food and estimate how much is available for donation. The restaurant can then schedule a pickup time with a nearby food bank using the app's streamlined scheduling feature.

On the other hand, a food bank user logs into the app to view available donations and schedule pickups. The app's real-time notifications ensure that community organizations can respond quickly to available donations, reducing the amount of food that goes to waste. By facilitating the efficient distribution of excess food, the app helps to address the issue of food waste while also supporting food-insecure populations in local communities.

Overall, this solution offers significant economic, social, and environmental benefits by reducing food waste, increasing food donations, and improving the efficiency of food recovery. The model of the app can also be applied to other industries and contexts where excess resources exist, making it a scalable solution to reducing waste and improving efficiency.

1.2 Significance and Broader Impact:

The proposed mobile application has significant implications for reducing food waste in the restaurant industry and addressing food insecurity in local communities. By streamlining the donation process, our app can improve the efficiency of food recovery and reduce the amount of food that goes to waste. Real-time notifications and pickup scheduling provide a unique and efficient solution for both restaurants and community organizations. Moreover, our app has additional unique features such as donation scheduling, social sharing, and messaging, which further differentiate it from existing apps and offer a comprehensive solution to the problem of food waste in the restaurant industry.

The broader impact of our app extends beyond the restaurant industry. The model can be applied to other industries and contexts where excess resources exist, making it a scalable solution to reducing waste and improving efficiency. The reduction of food waste through our app can have a significant positive impact on the environment, as well as on the lives of people who rely on community organizations for their daily meals. By providing a platform for restaurants to donate their excess food to food banks, our app can help reduce food waste and address food insecurity in local communities. Furthermore, the real-time notifications and pickup scheduling provided by our app can help community organizations respond more quickly and efficiently to the needs of their clients. Overall, the proposed app offers a comprehensive and replicable solution to reducing food waste and improving efficiency, with significant economic, social, and environmental benefits.

2. Related Work:

Based on our research questions, we researched the existing articles related to food waste management in restaurants. We wanted to understand the measures taken in the restaurant's kitchen to reduce food wastage. KNOBIE is a design intervention aimed at supporting chefs in their sustainable recipe planning practices. The intervention involves a tool that allows chefs to compare the environmental impact of different recipe ingredients and make more sustainable choices. The KNOBIE tool uses a color-coding system to indicate the sustainability of different ingredients. Green indicates the most sustainable option, while red indicates the least sustainable option. Chefs can also input the quantity of each ingredient they plan to use and get a summary of the overall environmental impact of the recipe.[6] However, KNOBIE has its limitations as KNOBIE is designed specifically for chefs, and its usefulness is limited to recipe planning. It does not address how the left-over food can be used.

The article "Food Talks Back: Exploring the Role of Mobile Applications in Reducing Domestic Food Wastage Geremy Farr-Wharton Jaz Hee-Jeong Choi Marcus Foth " presents a case study of a mobile application called Food Talks Back, which was designed to help users reduce food waste by tracking the food they have in their home and providing suggestions for recipes that use those ingredients. The authors discuss the potential of mobile applications to address other aspects of food waste, such as food spoilage and food packaging waste. They argue that mobile applications can provide users with information on how to store food properly and can help users make more informed decisions about the products they buy and the packaging they choose [8]. This research shows some measures to reduce food waste but there will be a certain amount of food which will be wasted. They could have added a feature where the restaurants could connect with nearby food banks and donate the leftover food in just a few minutes by scheduling a pickup time etc.

The article "It Takes a Network to Get Dinner: Designing Location- Based Systems to Address Local Food Needs" discusses the importance of designing location-based systems to address local food needs. They suggest that technology can play a vital role in creating more efficient and sustainable food systems. The authors highlight the potential benefits of location-based systems, such as reducing food waste, supporting local farmers, and improving access to healthy and sustainable food. They also acknowledge some of the challenges and limitations of these systems, such as the need for robust infrastructure and the potential for exclusion of marginalized communities [7]. However, the article does not address how to keep track of food that has been donated and wasted.

The paper "Ways to Reduce Restaurant Industry Food Waste Costs" by David Blum, DBA discusses various strategies that restaurants can implement to reduce their food waste costs. The paper suggests conducting a waste audit to identify the types and amounts of food being wasted, and then implementing strategies such

as adjusting portion sizes, improving inventory management, and finding creative ways to use leftovers. Other strategies suggested in the paper include composting, donating excess food to food banks or shelters, and educating staff and customers about the importance of reducing food waste. By taking these steps, restaurants can save money on food waste costs and demonstrate their commitment to sustainability and social responsibility [9].

These articles talk about various methods to control food wastage in restaurants but one of them talks about distributing leftover food to the food banks. Though one of the articles mentions distributing leftover food to the food banks, they have not come up with a solution on how to implement the system. Here, we identify the scope of our study and research on the existing applications which deal with leftover food from restaurants. We further investigated the existing applications that aim to reduce food waste. Some of the applications we found include MealPal, Too Good to Go, Savor, Food Rescue Hero, and Goodr. MealPal and Too Good to Go are similar apps that allow users to order affordable meals from local restaurants at discounted prices. With a variety of dishes and cuisines available, users can pre-order their meals for pickup and enjoy high-quality food at a lower cost than dining out regularly. Although these apps aim to reduce food waste, they may not be accessible to people who cannot afford to pay for food. On the other hand, Food Rescue Hero is a mobile application designed to connect volunteers with surplus food from local businesses and events to nonprofit organizations that can distribute it to people in need. Our platform is based on the concept of the Food Rescue App, but with additional features to increase the efficiency of food donations from restaurants.

3. Problem Statement

Previous studies and existing applications have attempted to tackle food waste through various mechanisms such as reduced meal plans, location-based tracking systems to connect people in need with food banks, and reselling leftover food at lower prices. While these solutions may help reduce waste to some extent, they may not provide a long-term solution, particularly for restaurants. Therefore, our study aims to explore the potential of using technology to solve food waste issues in restaurants. By implementing a technological solution, we can ensure consistent improvement and data analysis to inform future improvements. Furthermore, we aim to build a bridge between restaurants with excess food and food banks to ensure the efficient donation of leftover food to those in need. This raises the question of how we can support restaurants and food banks effectively. To ensure the app's efficiency and continuous improvement, we must address any issues and identify the features that can enhance its effectiveness. Therefore, our final research questions are: "What existing technologies are available?" and "What features can improve the efficiency of reducing food waste?"

4. Methodology

4.1 Methodology Overview:

The aim of this study was to gain insight into the experiences and perspectives of restaurant workers regarding food waste and donation. We conducted user interviews with employees of four local restaurants to identify the main factors that contribute to food waste and explore potential solutions to this problem. Our research questions were: How can we control food waste from restaurants using technology?", "How can we support restaurants and food banks?", "What existing technologies are available?", and "What features can improve the efficiency of reducing food waste?

4.2 Experimental Procedure:

To gather data from restaurant workers, we used a semi-structured interview format. The interviews were conducted in-person, with one interviewer and one participant present at each session. We explained the purpose of the study and obtained informed consent from each participant before asking a series of open-ended questions such as "What types of food are most commonly wasted in your restaurant?" and "What challenges do you face when trying to donate surplus food?". The interviews were audio-recorded and transcribed for analysis.

We also analyzed and compared existing apps and services that address food waste and food donation in the restaurant industry, examining their features, user interface, and effectiveness. This allowed us to identify gaps in the market and determine what unique features our app could offer.

We used affinity mapping to organize and synthesize the data from the user interviews and created user flow to visualize the user experience. Affinity mapping helped us identify common themes and patterns across the data, while user flow allowed us to develop a clear understanding of the steps involved in the donation process. We used affinity mapping to categorize challenges mentioned in the interview transcripts into three major categories: Management, Food Hygiene & Policies, and Food Waste & Technology. Challenges related to each area were identified and categorized accordingly. For instance, under the Management category, concerns regarding supply chain management with cold storage, and cold storage itself were the most common challenges mentioned by restaurants. Within the Food Hygiene & Policies category, ensuring food safety, making sure that donated food is safe for consumption, and concerns about the risk of illness from donated food were prioritized. Finally, under the Technology category, most restaurants were not interested in using applications or technology due to issues of accessibility and lengthy setup processes. Figure [1] provides a visual representation of these findings.

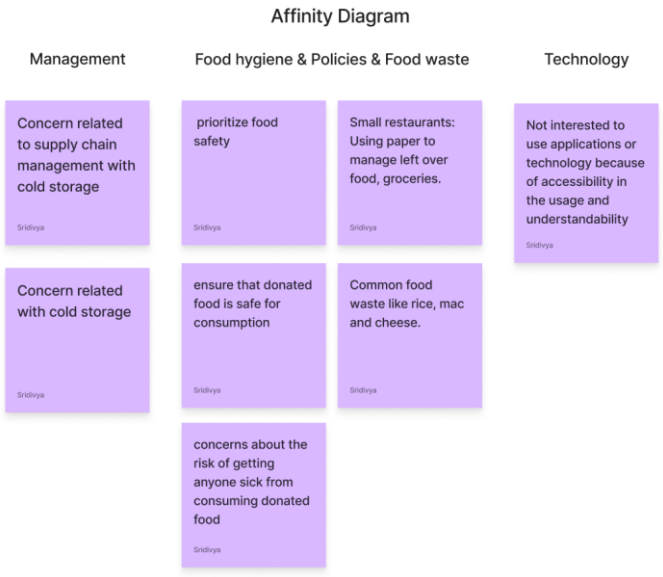

Figure [1]: Affinity Mapping

4.3 Participants:

We recruited participants from four local restaurants: Chipotle, Barbecue, Subway, and Nandhana Palace. We chose these restaurants based on their popularity and their willingness to participate in the study. We approached each restaurant and explained the purpose of the study, emphasizing that their insights would help us develop a mobile app to reduce food waste and connect surplus food with community organizations in need. We obtained informed consent from each participant and conducted interviews with at least one participant from each restaurant, for a total of four participants.

In conclusion, our methodology involved conducting user interviews with restaurant workers, researching existing apps and services, using affinity mapping and user flow to synthesize the data, and recruiting participants from four local restaurants. Through these methods, we aimed to gain a comprehensive understanding of the factors that contribute to food waste in the restaurant industry and develop a mobile app that could help restaurants reduce their food waste and make a positive impact on their communities.

5. System Design

Our mobile application is designed to reduce food waste in the restaurant industry by facilitating donations to local community organizations. The design system includes the user flow and user interfaces for both the restaurant and food bank sides of the application.

5.1 User Flow

The user flow Figure [2] for our mobile application begins with the login screen for both restaurant and food bank users. After logging in, restaurants are directed to their dashboard, where they can create a donation post, search for nearby community organizations, and view their ongoing and completed donations. Meanwhile, food banks are directed to their home screen, where they can view requests from restaurants, track donations, and view analytics.

When a restaurant user creates a donation post, they are prompted to input details about the donation, such as the type of food and quantity available. They can also select a nearby community organization from a list of suggestions, or search for a specific organization if it is not listed. Once a community organization has been selected, the restaurant user can view their profile and policies to ensure that their donation aligns with the organization's needs.

When a food bank user receives a request for a donation, they can view the details of the donation, such as the type and quantity of food, and accept or decline the request. If they accept the request, they can track the status of the donation as it is picked up and delivered to the food bank.

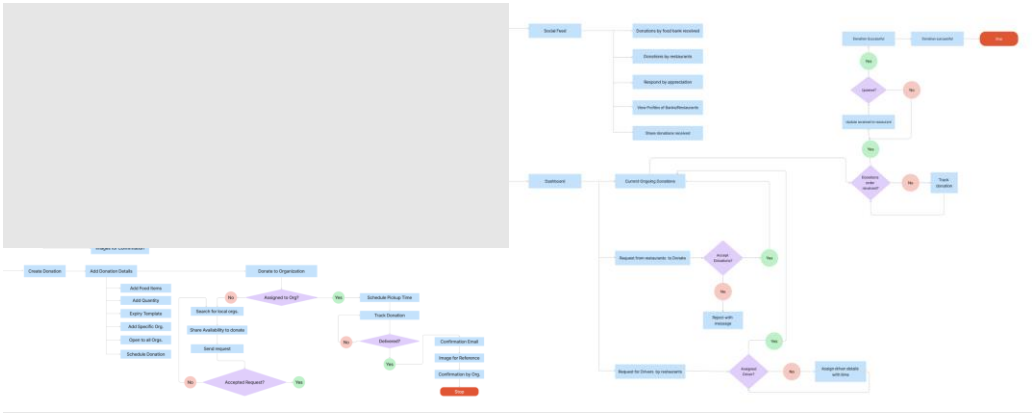

Figure [2] Restaurant & Food Bank User Flow Model – Full Flow Link

5.2 Restaurant User Interface

The restaurant user interface Figure [3] features a login page, a dashboard that displays the restaurant's donation history and the number of donations made, a social share page, a messages page for communication with food banks, a profile page that allows restaurants to manage their account information, and a page to create a donation post. The restaurant user interface also includes pages for searching and selecting nearby food banks to donate surplus food to. The pages are designed to be simple and intuitive, with clear labels and visual cues to guide the user through creating and managing donations.

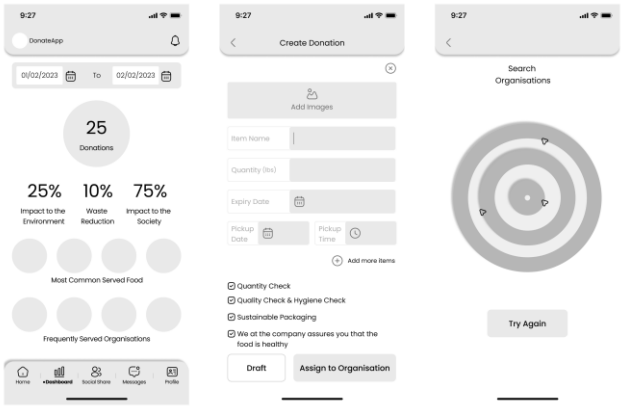

Figure [3]: Restaurant Interface

5.3 Food Bank User Interface

The food bank user interface Figure [4] features a login page, a home page that displays donation requests from restaurants and available drivers, a dashboard with analytics on donations received, a social share page, a messages page for communication with restaurants, and a profile page that allows food banks to manage their account information. The pages are designed to be clear and easy to navigate, with a focus on facilitating the donation process. The food bank user interface includes a page to track donations, with information on the restaurant, driver, and food type being donated. The design is intended to provide a smooth and efficient user experience for food banks to receive and manage donations from restaurants.

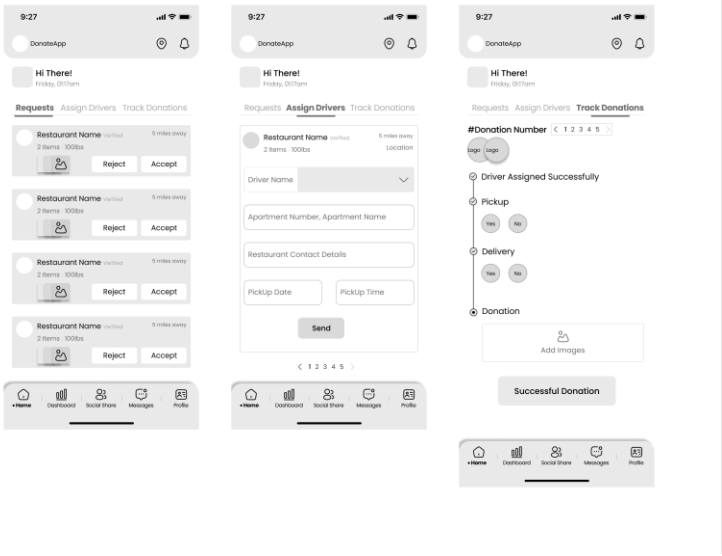

Figure [4]: Food Bank Interface

Overall, the proposed system is designed to be intuitive and user-friendly, with features that cater to the specific needs of both restaurant and food bank users. By providing a platform for easy and efficient donation of excess food, the system aims to reduce food waste and promote sustainability in the food industry.

6. Results

Beginning with conducting interviews, we successfully recruited four restaurants to participate in our study and answer our questions regarding food waste, including topics such as commonly wasted food items, food donations, and the use of technology to tackle waste. Our findings revealed that each restaurant had different perspectives and methods for controlling food waste. The primary focus of our study was to reduce food waste through technology and to address the following questions: "How can we control food waste from restaurants using technology?", "How can we support restaurants and food banks?", "What existing technologies are available?", and "What features can improve the efficiency of reducing food waste?".

While some restaurants do not currently donate leftover food to food banks or similar organizations, others are limited by concerns about the safety of donated food. Additionally, certain types of food, such as rice or mac and cheese, are commonly wasted, and sustainability and social responsibility may not be part of some restaurants' values and operations. Policy restrictions often prevent restaurants from donating leftover food, although it may still be consumable the next day. Restaurants rely on their own connections with food banks, NGOs, or organizations for donations, with some experiencing difficulty in finding suitable partners.

Further research was conducted on existing apps that aim to reduce food waste, such as Too Good to Go, Savor, Food Rescue Hero, and Goodr. These apps either facilitate food donation or allow the purchase of surplus food at a discounted price. However, location is a key requirement for food pickup in these apps, and some of them focus only on selling leftover food or limit the types of food that can be donated.

Therefore, we propose the development of a platform that primarily focuses on converting leftover food from restaurants into meals for food-insecure individuals, which can be shared through food organizations/food banks. We realized while sketching out the user flow model that another user flow model for food organizations/food banks is required to form a bridge between restaurants and food organizations/food banks to donate food.

To analyze the data, we utilized an affinity mapping technique. Our analysis revealed that restaurants face significant challenges in tracking and managing food waste, often resorting to paper-based sheets which are difficult to keep track of and can result in the loss of data. We also identified that restaurants encounter difficulties in finding and connecting with food organizations for donations. Our research found that existing applications mainly focus on selling leftover food at lower prices or accepting package or preserved food donations. To improve the efficiency of reducing food waste, we suggest developing easy-to-use technology solutions that require minimal effort to access and operate.

Although our research provides a promising solution for reducing food waste, some limitations were identified. We were unable to address the aspect of food safety [10] and the dynamic policies of restaurants, which may lead to confusion among food organizations during food donation. Additionally, our research predominantly utilized qualitative analysis rather than quantitative analysis due to resource constraints, which may limit its generalizability beyond the four restaurants included in the study. Further research is needed to validate the effectiveness of our proposed solutions across a broader range of restaurants.

7. Discussion

The aim of our study was to develop an efficient solution for controlling food waste from restaurants by exploring features that could improve the process of donating food. Our results indicated that a technology-based platform could be used to connect restaurants with food organizations/food banks to facilitate donations and keep track of their donations.

Through our interviews, we identified that restaurants struggle with managing and tracking food waste. To address this issue, our prototype includes a tracking system that allows users to monitor ongoing donations and review donation history. Additionally, we incorporated an analytics tool to generate overall statistics to showcase the positive impact of reducing food waste and help restaurants improve their meal plans accordingly.

Contrary to our initial hypothesis, we discovered that restaurants struggle to find food banks that can accept their donations [11]. We also learned that some restaurants refrain from donating due to concerns over food safety. To address these issues, we developed a digital prototype with a seamless tracking system, digital entry of items, and simple ways to connect with food organizations willing to accept donations. We also implemented a cross-checking system to verify the quality of donated food and ensure clear communication regarding terms and conditions.

Our prototype features Social Share, which allows restaurants and food organizations to share their donations and inspire others to reduce food waste, thereby having a positive impact on the environment and society. However, we recognize that our prototype's information regarding food quality and policies may become outdated, potentially undermining trust and leading to unethical donations.

We recommend exploring additional technologies that can make the process more effortless and user-friendly. We also suggest conducting usability testing to receive feedback from end-users. Finally, we recommend conducting qualitative analysis with food banks to understand their challenges when

collaborating with restaurants to improve the effectiveness of the study. Clear documentation of the entire process, including failed hypotheses, would be beneficial for future reference.

8. Conclusion & Future Work

Our study proposes a technology-based solution for reducing food waste in restaurants through food donations to food organizations and banks, ensuring that surplus food reaches the food-insecure community. Our research emphasizes the need for a tracking system to help restaurants manage their food donations. The analytic tool feature can aid in reducing food waste by providing restaurants and food banks with the amount of environmental impact, motivating restaurants to maintain consistency in their donations. Furthermore, we found that the paper-based method of tracking food wastage used by restaurants is inefficient and recommend digitalizing the process for easier accessibility of data.

However, our study has some limitations. We could not provide information on food donation policies, which are subject to change based on different use-case conditions. Additionally, our research mainly relied on qualitative analysis due to resource constraints, which may limit its generalizability beyond the four restaurants studied. We did include a checklist for ensuring food quality but could not address the aspect of food safety.

Future research should explore additional technologies to improve the process's ease and user-friendliness, conduct usability testing to gather feedback from end-users, and include qualitative analysis with food banks to better understand their challenges in collaborating with restaurants. Furthermore, clear documentation of the entire process, including failed hypotheses, would be beneficial for future reference.

References:

[1] J, B. and D, P.(eds.) (2019) The State of Food and Agriculture 2019. Moving forward on food loss and waste reduction |Policy Support and Governance| Food and Agriculture Organization of the United Nations: link

[2] Gunders, D. (2012). Wasted: How America is Losing Up to 40 Percent of Its Food from Farm to Fork to Landfill. Natural Resources Defense Council. Link

[3] ReFED. (2018). Insights Engine: Restaurant Food Waste Action Guide. Link

[4] Business Insider. (2018). Americans waste an absurd amount of food – here are the worst offenders.Link

[5] Second Harvest. (2021). Restaurant food donation

[6] KNOBIE: A Design Intervention for Supporting Chefs' Sustainable Recipe Planning Practices. Hüseyin Ugur Genç KUAR, Koç University, Istanbul, Turkey, Hakan Yilmazer KUAR, Koç University, Istanbul, Turkey, Aykut Coskun KUAR, Koç University, Istanbul, Turkey: HYPE

[7] A It Takes a Network to Get Dinner: Designing Location Based Systems to Address Local Food Needs. Lynn Dombrowski, Jed R. Brubaker, Sen H. Hirano, Melissa Mazmanian, Gillian R. Hayes. Department of Informatics, University of California, Irvine: Link

[8] Food talks back: exploring the role of mobile applications in reducing domestic food wastage – Food apps (Fridge Pal, LeftoverSwap and EatChaFood). Geremy Farr-Wharton Jaz Hee-Jeong Choi Marcus Foth, Urban Informatics Research Lab Queensland University of Technology, 2 George St, Brisbane QLD 4000: Link

[9] Ways to Reduce Restaurant Industry Food Waste Costs" by David Blum, DBA. Link

[10] Exploring the case of a local food bank to understand information technology use in government information networks. Joana Carvalho, Centro ALGORITMI, University of Minho & United Nations University (UNU-EGOV) Portugal, Rui Dinis Sousa,Centro ALGORITMI, University of Minho Portugal: Link

[11] A Recommender System for Crowdsourcing Food Rescue Platforms Link

[12] Restaurant Food Waste – How Much Food Is Thrown Away by Restaurants & Why? Link

[13] Reduce Wasted Food by Feeding Hungry People: United States Environmental Protection agencyLink

[14] The Problem of Food Waste, Published: 10/08/18 Link

[15] Reducing Food Waste in Buffet Restaurants: A Corporate Management Approach, Chi-Mei Emily Wu and Chih-Ching Teng.

[16] An Approach for Creation of Logistics Management System for Food Banks Based on Reinforcement Learning (logistics management system for the food banks to improve the efficiency of their food delivery)

[17] Queuing for Waste: Sociotechnical Interactions within a Food Sharing Community (through the work of volunteers - surplus food is transformed from a commodity to a gift)

[18] Poster: Pallet Estimation for Food Bank Logistics Management (resource allocation by reducing uncertainty in the number of pallets needed)

[19] Parfitt J, Barthel M, Macnaughton S. Food waste within food supply chains: quantification and potential for change to 2050. Philos Trans R Soc Lond B Biol Sci. 2010 Sep 27;365(1554):3065-81. doi: 10.1098/rstb.2010.0126. PMID: 20713403; PMCID: PMC2935112.

[20] Vermeulen, S. J., Campbell, B. M., & Ingram, J. S. (2012). Climate change and food systems. Annual Review of Environment and Resources, 37, 195-222 Link

[21] Lipinski, B., Hanson, C., Lomax, J., Kitinoja, L., Waite, R., & Searchinger, T. (2013). Reducing food loss and waste. Working paper, World Resources Institute Link

[22] Gunders, D. (2012). Wasted: How America Is Losing Up to 40 Percent of Its Food from Farm to Fork to Landfill. Natural Resources Defense Council (NRDC).Link

[23] Environmental Protection Agency (EPA). (2021). Food Recovery HierarchyLink

[24] Harvard Law School Food Law and Policy Clinic. (2017). Don't Waste, Donate: Enhancing Food Donations Through Federal Policy Link

[25] Food Waste Management Using Machine Learning: 1st Vinayak Bharadi,2nd Pavan Jadhav,3rd Omkar Nanche,4th Onkar Munj Link

[26] Walden University, Minneapolis, Minnesota, United StatesLink

[27] Restaurant Waste Management; Perception of Restaurant Managers on the New Practices and Challenges in Dubrovnik, Nika Saric RIT, Croatia May 2019: Link

[28] Food waste prevention in quick service restaurants: A comparative case study on the quantity, source, cost and cause, by; Tess Drewett Link

[29] Restaurant food waste and the determinants of its effective management in T Bulgaria: An exploratory case study of restaurants in Plovdiv: Viachaslau Filimaua, ∗, Hafiza Fidan, Iordanka Alexiea, Stefan Dragovic, Denitsa Dimitrova Marinova Link

[30] Post-consumer food waste generation while dining out: A close-up view, by: Myra Zeineddine[1], Samer Kharroubi[1], Ali Chalak [2], Hussein Hassan[3], Mohamad G. Abiad Link