KNOBIE: A Design Intervention for Supporting Chefs' Sustainable Recipe Planning Practices

Hüseyin Ugur Genç
KUAR, Koç University, Istanbul, Turkey
hgenc17@ku.edu.tr

Hakan Yilmazer
KUAR, Koç University, Istanbul, Turkey
hyilmazer18@ku.edu.tr

Aykut Coskun
KUAR, Koç University, Istanbul, Turkey
aykutcoskun@ku.edu.tr

ABSTRACT

Reducing the environmental impact of current food production and consumption practices is a significant challenge for a more sustainable future. Even though previous HCI studies illustrated that design interventions could support more sustainable food practices in domestic contexts, little attention has been given to hospitality contexts (e.g., restaurants). Addressing this gap, we first investigated food preparation practices in restaurants (i.e., how recipes, menus and meals are prepared) through interviews with 10 chefs and instructors of culinary arts. Then, we designed KNOBIE, a design intervention aimed at supporting chefs' sustainable food preparation practices through better recipe and menu planning. In this paper, we present the results of these interviews, KNOBIE as a concept to support sustainable recipe planning and how interviews guided its design.

CCS CONCEPTS

• **Human-centered computing** → Human computer interaction (HCI); Interaction design.

KEYWORDS

Sustainability, Sustainable HCI, food, chef, the hospitality sector, restaurants

ACM Reference Format:
Hüseyin Ugur Genç, Hakan Yilmazer, and Aykut Coskun. 2021. KNOBIE: A Design Intervention for Supporting Chefs' Sustainable Recipe Planning Practices. In *Fifteenth International Conference on Tangible, Embedded, and Embodied Interaction (TEI '21), February 14–17, 2021, Salzburg, Austria.* ACM, New York, NY, USA, 6 pages. https://doi.org/10.1145/3430524.3442471

1 INTRODUCTION

Food production and consumption practices are regarded as one of the most significant contributors to climate change [4]. Energy and resources consumed during production, transportation, storage, preparation, and disposal of food negatively influence climate, water, land, and biodiversity [8]. Thus, supporting more sustainable practices around food has been identified as a significant challenge at the UN level [26].

Permission to make digital or hard copies of part or all of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for third-party components of this work must be honored. For all other uses, contact the owner/author(s).
TEI '21, February 14–17, 2021, Salzburg, Austria
© 2021 Copyright held by the owner/author(s).
ACM ISBN 978-1-4503-8213-7/21/02.
https://doi.org/10.1145/3430524.3442471

Previous HCI studies have explored various approaches to address this challenge. One approach is promoting alternative food provision sources such as city farming and urban food-growing communities [6, 14, 19]. Another approach is increasing users' awareness of underutilized crops [18], the nutritional value of food [1], and cooking techniques [12] by using multimedia platforms [5] or systems integrated to existing food-related products like trolleys [16]. There are also various solutions to support food waste prevention practices such as monitoring expiry date [20], online food waste diaries [10], showing wasted food via social media [2], sharing leftovers via drones [3] or online platforms [11].

Despite all these efforts, unsustainable food preparation practices in restaurants are a significant but underexplored topic in HCI. For example, two separate studies indicate that the majority of avoidable food waste in restaurants occurs at the preparation, 45% [28], 65 % [21]. Gathering insights from chefs is essential to develop any interventions aimed at reducing food waste in restaurants. Considering the journey of the food from producer to consumer, chefs provide great potential for design interventions due to their unique position as a critical decision point between the final user and produce. Their decisions towards individual menu items and their recipes are what determine the produce that will be used and how it will be used. At the same time, the way each dish is prepared gives us unique opportunities in terms of conveying messages to consumers, by the means of presentation, choice of ingredients, cooking methods used, etc.

Current literature lacks solutions aimed at reducing food waste in restaurants from the chef's perspective. Even though there are some examples that aim to assist chefs' practices by the means of cooking assistants [12, 25], they don't focus on sustainability and impact of food waste. In order to tap into this potential, we first investigated existing food preparation practices of seven chefs and three instructors of culinary arts through semi-structured interviews. We then designed KNOBIE, a recipe and menu planner that allows chefs i) to create and assess recipes across four dimensions (locality, seasonality, frugality, novelty) and ii) to revise these recipes based on ingredient suggestions. We make the following contributions to the literature. First, we provide an account of chefs' food preparation practices from a sustainability view (knowledge contribution). Second, we present a recipe and meal planner designed based on this account (artefact contribution).

2 INTERVIEWS WITH CHEFS

Since our aim was to understand chef's food preparation practices, we investigated three questions during the semi-structured interviews. These are (1) *How do chefs work?* (2) *How do they develop a*

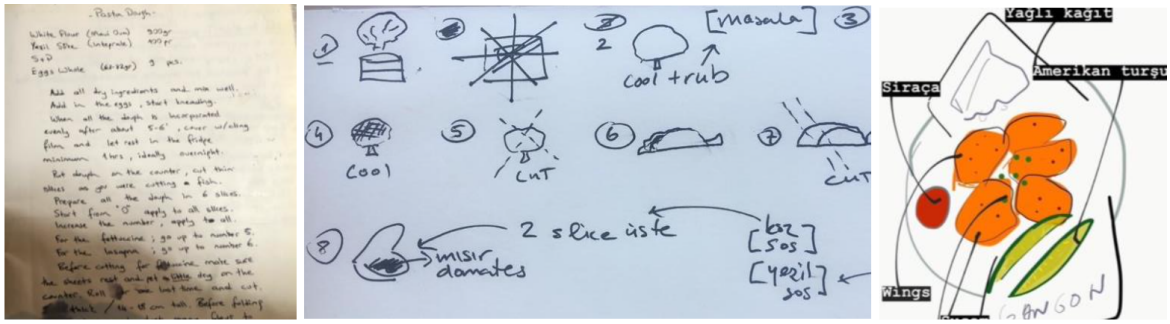


Figure 1: Types of the documenting a recipe a) Text-based, b) Pictogram-based, c) Digital

recipe and a menu? (3) *How should a good and sustainable recipe and menu be?*

Six of the participants were female whilst four of them were male. They had varying years of professional experience, lowest being six and highest being 19, with a median of 13. Also, seven of them were chefs in practice while three of them were working as culinary instructors. Their expertise in culinary arts was also widespread. Three chefs worked in fine dining, two of them being in ethnic cuisines. Two chefs were specialized in fast casual, one working in contemporary casual. Finally, one chef owned her own street food truck. We used our personal contacts and chefs' personal social media accounts to recruit participants. Five chefs were recruited via direct messaging service of Instagram. We also used the snowball sampling method to recruit other chefs. For the culinary arts instructors, we contacted two of the most popular culinary art schools in Istanbul and they spread our research brief, to help us find instructors for the interview.

In the interviews, we inform the participants that the study is about food preparation practices and sustainability in kitchens. The purpose of the interviews was to gain an in-depth understanding of chefs' recipe development process, and their considerations for a 'good' and 'sustainable' recipe.

Each interview lasted about one hour and forty minutes. Each was voice-recorded and transcribed into text. We analyzed them through qualitative coding [17]. We first read the transcripts to familiarize ourselves with the data, and then we coded them by following a deductive approach, using the questions as categories. Then, we re-coded each category by following an inductive approach, with codes derived from the data. New categories were identified with this approach. After coding the first transcripts separately, we discussed the compatibility of our codes and agreed-upon a common view.

We present our findings in two categories. First, we unwrap the details of the chefs' working practices *(process and methods for recipe generation)*. Second, we explain the four criteria for a good and sustainable recipe *(seasonality, locality, frugality, novelty)*.

2.1 How Do Chefs Work?

The interviews showed that chefs involve in a creative process in the kitchen and carry out their work in a designerly way [7]. Following an iterative process, they take notes, draw, and organize tasting and critics sessions with their staff to develop recipes for the restaurants. All chefs stated that a good chef should know the cooking, preparing and presentation techniques along with the characteristics of ingredients like smell, taste, texture and so on. Since tacit knowledge [23] plays a major role in their work, the chefs further stressed that it is very important to gain and improve this knowledge through practice. This knowledge is primarily acquired by trial and error. "*The ideas first form in my mind and then I write it. Then change the recipe according to the trials. Try and Improve it. Try and improve. . . I've tried 20-25 times for designing a recipe" (Chef 7).*

Experiencing new cultures, new tastes, and new techniques, experimenting with different ingredients (e.g., tinkering with the material [22]), constantly taking inspiration from these experiences, and taking notes of them are key to develop a good collection of recipes. Due to this ongoing process of learning, all of the chefs have their own notebooks in which they take notes not only things related to trial processes but also inspirational notes, ideas, state of the stocks of their restaurants, recipes, to-do's, and so on.

In addition to this note-taking routine (Figure 1a), chefs also use more visual techniques to express their ideas (Figure 1b). They use drawings to enhance their way of thinking, communication with others in their team, or to sustain a particular level of presentation. For example, one chef explained how she designed a desert with different ingredients by drawing and coloring layers. In addition to these analog methods, they use digital platforms for recipe generation and sharing these instantly with colleagues. For example, one chef used a feature of Instagram to draw an illustration of her recipe to show it to her colleagues (Figure 1c).

Chefs use three different methods while creating new recipes: Bending, Blending, and Matching.

Bending is the replacement of the components from an already existing recipe. For example, a chef can create a whole new dish by only replacing some ingredients. It is the most common process of creating new recipes. With this method, chefs can adapt the materials and techniques from different cuisines. For instance, one chef combined taco and kebab. The result is still recognizable as shish kebab.

Blending is the process of creating a new and original recipe by combining the elements of two or more different dishes. When applying this method, the chefs took the main ideas behind a meal and constructed other things on those ideas. For example, a chef developed a brand-new main dish involving lamb, using the logic

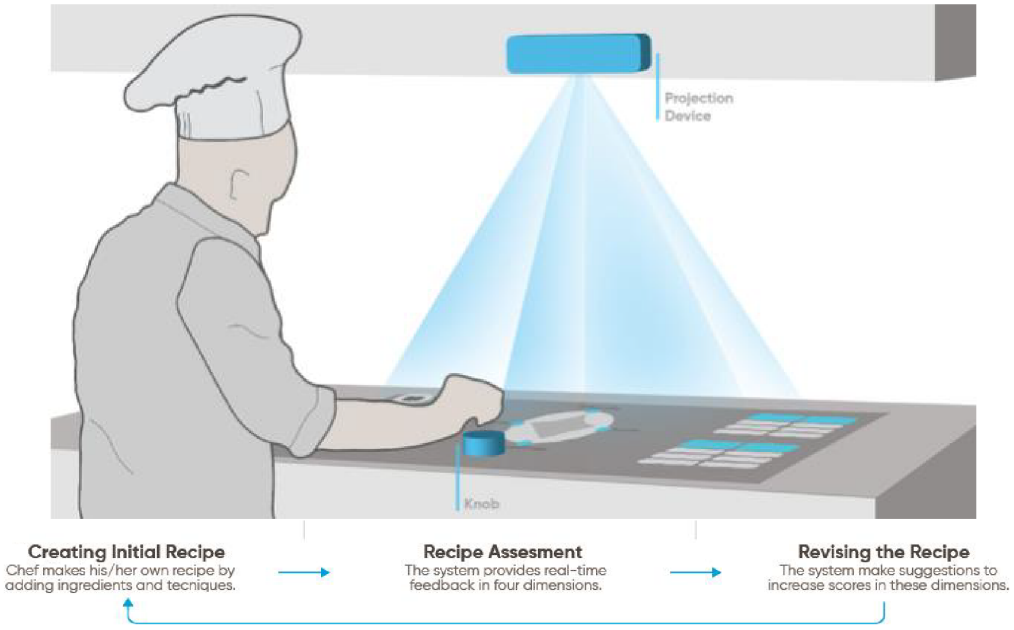


Figure 2: The flow of the usage scenario

behind a dessert. Taking the layered structure of this dessert, the chef reconstructs it using a salty pastry, lamb meat and toasted yoghurt. The resulting dish is not a dessert but is inspired by it.

Matching is a method to create a whole new taste. Chefs create dishes by matching the ingredients, without the inspiration of another recipe. In this method, the most important thing is having harmony between different tastes. Besides, making recipes containing seasonal products by matching is a process commonly used by chefs. One of the chefs we interviewed listed all the seasonal ingredients (i.e., vegetables, meats, fish, etc.) to select them one-by-one whilst creating his monthly menu.

2.2 Dimensions of a good and sustainable recipe

In this study, we investigated the logic behind menus and recipes that chefs offer in their restaurants and what criteria they take into consideration while constructing them. The interviews revealed that four dimensions can be used to assess the quality and sustainability of a recipe. These are seasonality, locality, frugality, and novelty. In addition to these four distinct dimensions, one of the main concerns of the chefs is the cost of the menu and the specific recipe. Chefs always consider the cost dimension in their operations, however, in the interviews they always mention that this dimension interacts with the other four dimensions.

2.2.1 Seasonality. Chefs stated that considering seasonality is a tactic that is not only good for the environment but also nurturing for their creativity. Participants made it clear that the use of seasonal products is also important because of commercial reasons, such as cost and flavor, even though they mentioned this importance with an environmental sentiment. According to the participants, changing menus frequently according to the seasons has become a trend. One chef said that it is enough to make menu changes twice a year, in summer and winter season, and that the autumn/spring transitions were tolerable. Three chefs took this further by being very strict about using seasonal ingredients, stated that the menu should change every 1-1,5 months.

2.2.2 Locality. Locality became another key point in the interviews. Purchasing from local producers also helped with the sustainability aspect. On the other hand, consistency of the local product supply is a constraint that chefs take into consideration. Most of the participants see this consistency as a must for adding ingredients to their menus. They also underlined the decrease in the quality of food, which may occur due to the limited production capacity of the local producer to satisfy large orders. Another chef, who always has locality and seasonality in her menu, argued that the menus should be flexible in terms of using another ingredient to stay local. According to her, this not only ensures the provision of high-quality local produce but also satisfies the customers' desire to consume local and quality food. Four chefs indicated that the lack of awareness in the production chain of the food creates an unclarity of a food's locality and harms the trust between stakeholders.

2.2.3 Frugality. Frugal use of resources, reducing waste and respecting the material were some of the most sensitive issues for chefs. Being frugal is a rule that should be well known and practiced by someone who deals with commerce as well as it is a requirement for being an environmentally conscious chef. In order to succeed as a restaurant, a chef should arrange their entire operation accordingly to prevent their wastage.

The participants said they consider frugality not for an individual recipe or a dish but for the menus. They implement a variety of practices to resolve this issue, such as root-to-stem approach [9, 15], which emphasizes using all the edible parts of the food. An



Figure 3: Concept – a) Chef chooses ingredients. b) Each dimension is scored; possible enhancements are shown in blue.

extension to this approach is to offer residues that can be used as a by-product, rather than part of a dish. This is more viable for products that need to be consumed rapidly. For example, when the chefs have excess amounts of anchovy, they served it as a paste along with the main dish. However, both approaches have some limits since the menu should have a balance in terms of ingredients and taste. A customer can expect as many different tastes and textures as possible throughout the experience.

2.2.4 Novelty. Another issue emphasized in the interviews is the uniqueness of a recipe. All the participants stated that there should be a difference in each recipe, which can be called "the chef's touch". Developing a brand-new recipe is also recognized as a fun and self-satisfying activity. Nevertheless, the issue of novelty seems to be a subject of debate among the participants, because it varies according to the place, time, and culture, and for chefs. Each recipe consists of criteria such as ingredients, balance between them, techniques used, seasonings, etc. Since many of these criteria are basics for cooking, little changes in them can create significance. A chef explains this issue by saying *"It is a different soup, but it is not a different soup. (Chef 6)"*.

3 KNOBIE: INTERACTIVE RECIPE PLANNING SYSTEM

Our interviews with chefs motivated us to design KNOBIE, an interactive recipe and menu planning system which allows chefs (1) to create recipes, (2) to evaluate the recipe according to five dimensions and (3) to get feedback and suggestions about ingredients (Figure 2). KNOBIE uses a projected display, providing chefs with a virtual experiment space on their countertops. Each KNOBIE piece is a wooden knob that works as individual controllers, motion-tracked by the display system (Figure 2, Figure 3). By using individual knobs like tangible cursors, chefs can interact with the recipes they create. In the following, we explain each of these activities in detail.

3.1 Creating new recipes

KNOBIE's main goal is to provide chefs a suitable medium for recipe development. Modular structure achieved by using multiple knobs also allow multiple users to work simultaneously on the display area. Gestures such as drag-drop, rotate and select, allows chefs to intuitively use bending, blending and matching methods during the recipe generation process. The interface also allows chefs to record and retrieve their previous recipes, custom ingredients, and combinations for personalized use. Thus, KNOBIE allows chefs to create their own recipes by selecting the ingredients and possible preparation techniques. They can start a recipe from scratch, or they can choose to create a recipe by bending or blending already-existing recipes by other chefs.

3.2 Recipe assessment

The second aspect of KNOBIE is the evaluation of a recipe. The recipes are assessed according to the five dimensions; locality, seasonality, frugality, cost and novelty. Locality suggests using locally produced ingredients (e.g., using Gorcola cheese over imported Parmesan cheese). Seasonality suggests using seasonal ingredients (e.g., using strawberry only during spring season). Frugality suggests using the ingredients to their fullest (e.g., using zucchini crust as pizza topping). Cost suggests using the ingredients cost efficiently (e.g., using horseradish instead of expensive Wasabi root). Novelty suggests using uncommon combinations of ingredients and techniques (e.g., mixing cherry with pickles). The recipe assessment changes dynamically, as the chefs develop their recipes, allowing them to reflect on their actions.

3.3 Recipe suggestions

Alongside the assessment process, KNOBIE can suggest new options accordingly. When the chefs want to see a specific evaluation of a dimension, they can filter the dimensions by selecting it and KNOBIE shows the problematic areas (ingredients, combinations, and techniques) in the recipe that lower its score. In the meantime, it makes suggestions on how to improve the recipe towards a more sustainable one by saying (e.g., "as this is not summer, you may want to use pomegranate instead of tomato for sourness"). Since these suggestions are given for each dimension, chefs may improve a certain dimension of the recipe according to their priority by considering these suggestions.

4 CONSIDERATIONS FOR DESIGNING KNOBIE

When designing KNOBIE, we considered several considerations derived from the interviews. We briefly explain these considerations

since they might provide guidance for other researchers and practitioners who are interest in designing recipe and menu planners for chefs.

4.1 DC1: KNOBIE supports collaborative work

All the chefs stated that activities in the kitchens require teamwork. When they design recipes for a menu, they come together and taste these recipes. They comment, give suggestions, or speculate new ideas about the recipes designed. One chef said that she organizes recipe generation events each month, where she selects one seasonal ingredient for all recipes that will be created. Each staff create their own recipe and present to the team. This collaborative type of work was always mentioned in our interviews. To follow through with this, we designed KNOBIE in a way that allows chefs (1) to create recipes (2) to present these recipes to various audiences (e.g., subordinates, superiors) and (3) to discuss and revise their recipe. Wide workspace provided by the projected display allows team members to work simultaneously on the recipe generation process.

4.2 DC2: KNOBIE provides space for ongoing exploration

Recipe planning is not a one-off attempt that happens in a particular time in a particular setting. Chefs have a long trial-and-error process during designing a recipe. This is an ongoing process where chefs constantly add knowledge (e.g., knowledge of techniques, materials, dishes) to their personal inventory. They prepare and try a recipe, then revise it afterwards. In this cycle, they note down their progress and ideas. Moreover, all the chefs stated that they collect inspirations during their daily lives. They always think about new possibilities for their inventory. Chefs can also create variations from a recipe they own, each variation focusing on a different aspect like seasonality or frugality depending on ingredient choices or simply experimenting on alternate ingredients in a dish for creating new tastes. They can work on these individual variations collaboratively, or by sharing, to further enhance the possibilities as well. Thus, recipe creation process of KNOBIE supports (1) increasing a chef's inventory of materials and techniques and (2) ideating/experimenting with this new knowledge.

4.3 DC3: KNOBIE encourages physical interactions in menu creation

One of the critical points observed during the interviews was chefs' tendency to work with their hands. Many of the chefs had notebooks and sketches that allowed them to archive their work whilst tinkering with them and helps them to work visually. For example, during a revision process in their recipe planning, they would note down their findings for future reference. This, in a sense, creates a medium for exploratory nature of their recipe creations. This physicality aspect also helps them connect to the process with their material senses since cooking experience is already a material experience. By the tangible design of the KNOBIE, chefs can experience (1) their traditional hands-on practices on the system, (2) and work visually as they prefer.

5 DISCUSSION

With an interactive recipe planning system like KNOBIE, a chef can mitigate the environmental impact of food preparation by producing seasonal, local, sustainable, and novel recipes. Even though we propose KNOBIE for restaurant kitchens, it might provide benefits for a wide range of user types and contexts. For example, it can be used in large operations such as big hotels and restaurant chains. By connecting stocks within the entire chain, it can track the stocks and suggest using certain ingredients or recipes to support frugal use of resources. Another addition to this idea may be a connected system amongst restaurants. As chefs stated in the interviews, they may be lacking some special parts of the products or have sheer amount of an ingredient in their stocks. This inter-restaurant connectivity provides a common stock for chefs.

Recipe creation and assessment aspect of KNOBIE may focus on the problematic areas of acquiring ingredients as well. HCI field can address these challenges arising from lack of transparency between various stakeholders in the food supply chain (e.g., producers, retailers, managers, chefs, consumers and so on). For instance, with the help of Blockchain technology, quality assurance of food products can be achieved [29]. In this system, all the factors interact in the food chain can be tracked, from the producers to the consumers, adding transparency to the key areas such as use of pesticides, amount of water, agricultural techniques etc. Moreover, this system can track the environmental impact of food products, increasing chefs' awareness.

Another context in which our concept might be beneficial is culinary education. This concept might be helpful for training the next generation of culinary art students by building awareness of sustainability and their role as a future chef in addressing environmental problems. The literature suggests increased awareness and knowledge are commonly cited as a necessary precursor to behavior change [27]. Thereby, with the awareness focus in education, the system can create the long-term sustainability benefits.

KNOBIE may be suitable for domestic context as well. One of the reasons of food waste in domestic contexts is not knowing what to cook, leaving purchased food in the refrigerator [13], or not knowing how to effectively accommodate for health conditions [24]. For instance, when it is synched to user's refrigerator, KNOBIE can lead to better stock control and cooking decisions.

6 CONCLUSION

In this paper, we aim to understand chef's food preparation practices and to design an intervention that might makes these practices more sustainable. We conducted ten semi-structured interviews with chefs and instructors of culinary art schools. We revealed (1) how they work, and (2) how they judge a good and sustainable recipe. We proposed KNOBIE, a design proposal which helps chefs mitigate their restaurants' environmental impact by arranging their food preparation practices in terms of recipe creation. We believe our work may encourage future researchers and practitioners who would like to design interactive systems for promoting sustainable food preparation practices.

REFERENCES

[1] Johan Aberg. 2009. An evaluation of a meal planning system: Ease of use and perceived usefulness. In *Proceedings of People and Computers XXIII Celebrating People and Technology (HCI '09)*. https://doi.org/10.14236/ewic/HCI2009.33

[2] Ferran Altarriba, Mathias Funk, Stefano Eugenio Lanzani, and Ana Torralba. 2017. The grumpy bin: Reducing food waste through playful social interactions. In *DIS 2017 Companion - Proceedings of the 2017 ACM Conference on Designing Interactive Systems (DIS '17)*. https://doi.org/10.1145/3064857.3079125

[3] Evan Burton, Hadi Skeini, Carolin Meier, Fahmida Zahan, and Raquel Olarte. 2017. AirShare: A food sharing concept. In *Proceedings of the 29th Australian Conference on Computer-Human Interaction (OZCHI '17)*. https://doi.org/10.1145/3152771.3154859

[4] Annika Carlsson-Kanyama and Alejandro D. González. 2009. Potential contributions of food consumption patterns to climate change. In *American Journal of Clinical Nutrition*. https://doi.org/10.3945/ajcn.2009.26736AA

[5] Alan Chamberlain and Chloe Griffiths. 2013. Taste and place: Design, HCI, location and food. In *CEA 2013 - Proceedings of the 5th International Workshop on Multimedia for Cooking and Eating Activities*. https://doi.org/10.1145/2506023.2506034

[6] Jaz Hee Jeong Choi and Eli Blevis. 2010. HCI & sustainable food culture: A design framework for engagement. In *NordiCHI 2010: Extending Boundaries - Proceedings of the 6th Nordic Conference on Human-Computer Interaction*. https://doi.org/10.1145/1868914.1868931

[7] Nigel Cross. 2001. *Designerly ways of knowing: Design discipline versus design science. Design issues, 17(3), 49-55*. https://doi.org/10.1007/1-84628-301-9

[8] FAO. 2014. *Food Wastage Footprint: Fool cost-accounting*. https://doi.org/ISBN 978-92-5-107752-8

[9] Anthony Fassio. 2013. Root to Stem: How Changing the Way We Think About Food Can Reduce Waste. *HuffPost*. Retrieved from https://www.huffpost.com/entry/food-waste_b_3943286

[10] Eva Ganglbauer, Geraldine Fitzpatrick, and Florian Guldenpfennig. 2015. Why and what did we throw out?: Probing on Reflection through the Food Waste Diary. *Proceedings of the ACM CHI'15 Conference on Human Factors in Computing Systems*. https://doi.org/10.1145/2702123.2702284

[11] Eva Ganglbauer, Geraldine Fitzpatrick, Özge Subasi, and Florian Güldenpfennig. 2014. Think globally, act locally: A case study of a free food sharing community and social networking. In *Proceedings of the ACM Conference on Computer Supported Cooperative Work, CSCW*. https://doi.org/10.1145/2531602.2531664

[12] Reiko Hamada, Shin'ichi Satoh, Jun Okabe, Shuichi Sakai, Ichiro Ide, and Hidehiko Tanaka. 2005. Cooking Navi: Assistant for daily cooking in kitchen. In *Proceedings of the 13th ACM International Conference on Multimedia, MM 2005*. https://doi.org/10.1145/1101149.1101228

[13] Marie Hebrok and Casper Boks. 2017. Household food waste: Drivers and potential intervention points for design – An extensive review. *Journal of Cleaner Production*. https://doi.org/10.1016/j.jclepro.2017.03.069

[14] Sara Heitlinger, Nick Bryan-Kinns, and Janis Jefferies. 2013. Sustainable HCI for grassroots urban food-growing communities. In *Proceedings of the 25th Australian Computer-Human Interaction Conference: Augmentation, Application, Innovation, Collaboration, OzCHI 2013*. https://doi.org/10.1145/2541016.2541023

[15] Helena Horton. 2019. Root-to-flower eating is to be food trend of 2019, experts say. *The Telegraph*. Retrieved from https://www.telegraph.co.uk/news/2019/01/08/root-flower-eating-food-trend-2019-experts-say

[16] Vaiva Kalnikaite, Yvonne Rogers, Jon Bird, Nicolas Villar, Khaled Bachour, Stephen Payne, Peter M. Todd, Johannes Schöning, Antonio Krüger, and Stefan Kreitmayer. 2011. How to nudge in situ: Designing lambent devices to deliver salient information in supermarkets. In *UbiComp'11 - Proceedings of the 2011 ACM Conference on Ubiquitous Computing*. https://doi.org/10.1145/2030112.2030115

[17] M.a. Miles,M.B. & Huberman. 1994. Qualitative data analysis: An expanded sourcebook (2nd ed.). *Qualitative data analysis: An expanded sourcebook (2nd ed.)*.20, 1: 159–160. https://doi.org/10.1016/S1098-2140(99)80125-8

[18] Kher Hui Ng, Victoria Shipp, Anya Skatova, and Benjamin Bedwell. 2015. What's cooking: A digital intervention to encourage sustainable food behaviour using mobile and wearable technologies. In *MobileHCI 2015 - Proceedings of the 17th International Conference on Human-Computer Interaction with Mobile Devices and Services Adjunct*. https://doi.org/10.1145/2786567.2794330

[19] William Odom. 2010. "Mate, we don't need a chip to tell us the soil's dry" opportunities for designing interactive systems to support urban food production. In *Proceedings of the 8th ACM Conference on Designing Interactive Systems (DIS '10)*. https://doi.org/10.1145/1858171.1858211

[20] Doenja Oogjes, Miguel Bruns, and Ron Wakkary. 2016. Lyssna: A Design Fiction to Reframe Food Waste. In *Proceedings of the 2016 ACM Conference Companion Publication on Designing Interactive Systems - DIS '16 Companion*. https://doi.org/10.1145/2908805.2909401

[21] Effie Papargyropoulou, Nigel Wright, Rodrigo Lozano, Julia Steinberger, Rory Padfield, and Zaini Ujang. 2016. Conceptual framework for the study of food waste generation and prevention in the hospitality sector. *Waste Management 49, 326-336*. https://doi.org/10.1016/j.wasman.2016.01.017

[22] Stefano Parisi, Valentina Rognoli, and Marieke Sonneveld. 2017. Material Tinkering. An inspirational approach for experiential learning and envisioning in product design education. *The Design Journal, 20:sup1, S1167-S1184*. https://doi.org/10.1080/14606925.2017.1353059

[23] Michael Polanyi. 1997. *The Tacit Dimension*. University of Chicago Press. https://doi.org/10.1016/b978-0-7506-9718-7.50010-x

[24] Yuka Shidochi, Tomokazu Takahashi, Ichiro Ide, and Hiroshi Murase. 2009. Finding replaceable materials in cooking recipe texts considering characteristic cooking actions. *ACM 2009 Workshop on Multimedia for Cooking and Eating Activities, CEA'09, Co-located with the 2009 ACM International Conference on Multimedia, MM'09*: 9–14. https://doi.org/10.1145/1630995.1630998

[25] Yasuyuki Shirai, Wataru Kobayashi, Kazuki Takei, Kengo Yoshizawa, and Naoki Sato. 2017. Discovering new creative mixtures of cooking ingredients. In *Proceedings of the 9th Workshop on Multimedia for Cooking and Eating Activities in conjunction with The 2017 International Joint Conference on Artificial Intelligence (CEA2017)*. https://doi.org/10.1145/3106668.3106678

[26] United Nations. 2019. *The Sustainable Development Goals Report 2019*. UN. https://doi.org/10.18356/55eb9109-en

[27] N. D. Weinstein. 1988. The precaution adoption process. *Health psychology: official journal of the Division of Health Psychology, American Psychological Association*. https://doi.org/10.1037/0278-6133.7.4.355

[28] WRAP. 2013. Overview of waste in the UK hospitality and food service sector.

[29] 2019. Ecuadorian Shrimp Producers Join IBM's Blockchain-Based Food Trust Ecosystem. Retrieved from https://www.cryptomak.co.uk/ecuadorian-shrimp-producers-join-ibms-blockchain-based-food-trust-ecosystem/