AMBROSIA | Food Sharing Ecosystem

RCA | Designing Services and Products with AI

Group 5

Members	Background	Programme
Andrea María Macian Burillo	Product Designer	M.A. in Visual & Experience Design
Venkatesh Shetye Chinmay	UX Designer	M.A. in Innovation Design Management
Ekin Birol	Industrial Designer	M.A. in Visual & Experience Design


Cook
Share
Search

ABSTRACT

Abstract

What does the project tackle? The project aims to tackle the problem of food waste to let more people be able to reach food, to reduce people's carbon footprints and to initiate dialog and stronger social connections among people.

What is the context? The project aims to tackle these problems in a food sharing ecosystem that allow people to share instead of throwing away in the context of **future of food, waste and socialization**.

Abstract

What are the key issues it addresses? How have these been developed?

Since the research has shown that a large portion of food waste happens because of people's inability to plan ahead and act upon when they notice an items will be going to waste despite their willingness and motivation to reduce their wastes. The key issues are therefore;

- ➔ analyzing consumer behaviour on food purchases
- ➔ finding ways to determine food waste with AI
- ➔ proposing new ways to prevent waste

Abstract

What methods have you used? ”Speculative Design” methods were used for the ideation process and methods from “Ethnographic Research” were implemented to gather information for the project. “Action Research” methods are being planned to further investigate the issues further in future research.

What are the key aspects/knowledge the project introduces to AI and the focus of study? The project aims to use the conveniences and the scope AI can offer to support people to build better habits regarding food purchase, consumption and sharing.

Abstract

Initial ideas from news stories:

Labrador Dog 'Recovering' After Eating Its Lead	Alligator on Helium Wins IG Nobel Price	Woman Labeled 'Genious' For Sharing 'Revolutionary' Way She Eats Duck Pancakes	Britain's Dullest Man Unveils the International Roundabout of the Year
Decision Making with AI. Advise on what to eat, what not to eat based on previous experiences with different foods. Future of Food	Using AI for fact-checking to determine false news, pseudo-science. Differentiating between real vs. fake Future of Safety (information)	Using AI to determine food items that are bought together, suggest these combinations to others and create recipe suggestions based on these patterns Future of Food	Using AI to define a persons insignificant memories and store them for their future and/or to assist people with dementia. Future of Care
Using AI to define what tool to select for the purpose of the work for a specific task to prevent confusion. Future of Workspaces	AI to detect stress levels in a social context from voice recognition and give advise to the user on ways of prevention. Future of Socialization	Using AI to determine different but more efficient usage of tool that leads to more efficient results in a given workspace and suggest the same techniques to the other employees to increase efficiency. Future of Workspace	Using AI to determine people's interests towards insignificant subjects and suggest these topics during their interaction with other people with similar mundane interests. Future of Socialization
Using an AI Tools to foresee and show the environmental consequences of buying habits such as showing the carbon footprint of a specific purchase) Future of Waste	Using AI assisted waste-bins to identify and sort waste according to their sound and texture to prevent mixing up. Future of Waste		
Using AI to create a friend/ boss/ parent/ partner to fill the shoes of lacking person in someone's life that would guide them. Future of Socialization			

Abstract

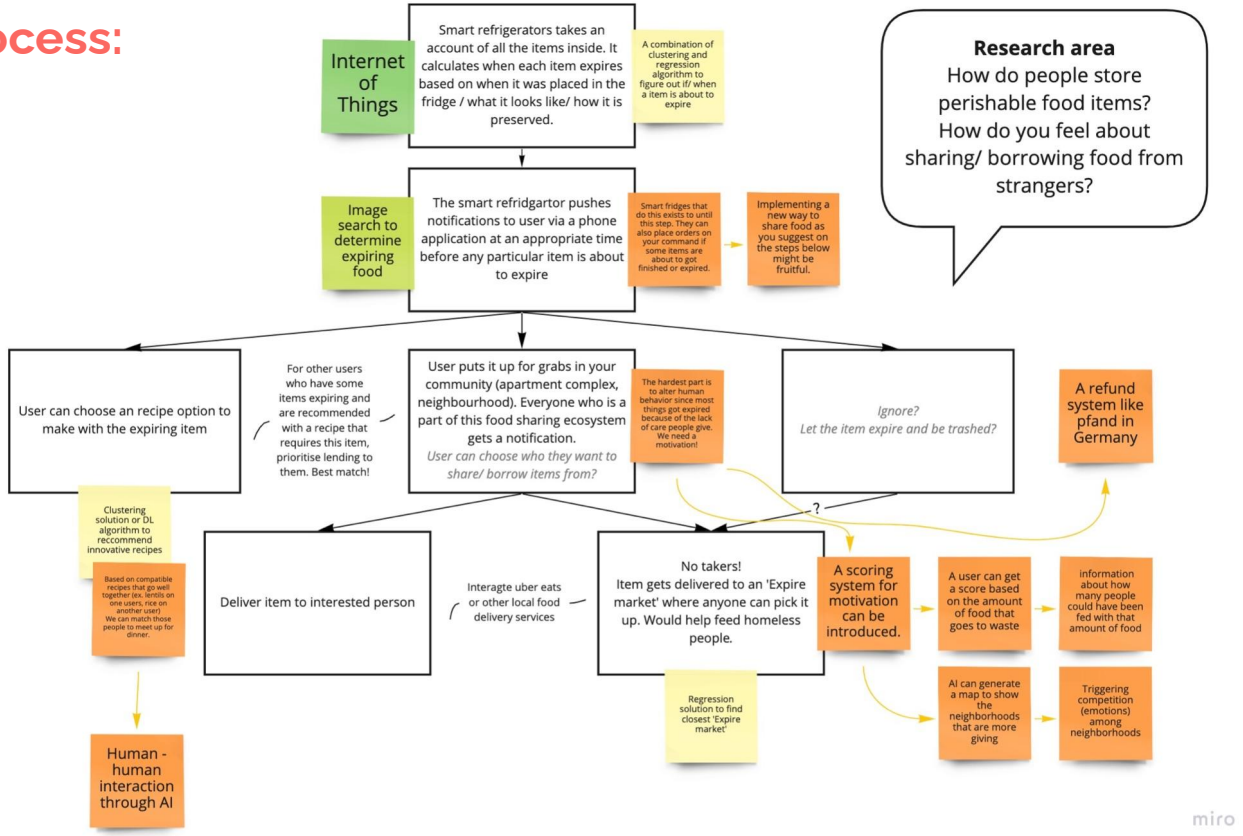
Initial ideas from news stories:

We selected one of our ideas to develop further.

Using AI to determine food items that are bought together, suggest these combinations to others and create recipe suggestions based on these patterns
Future of Food

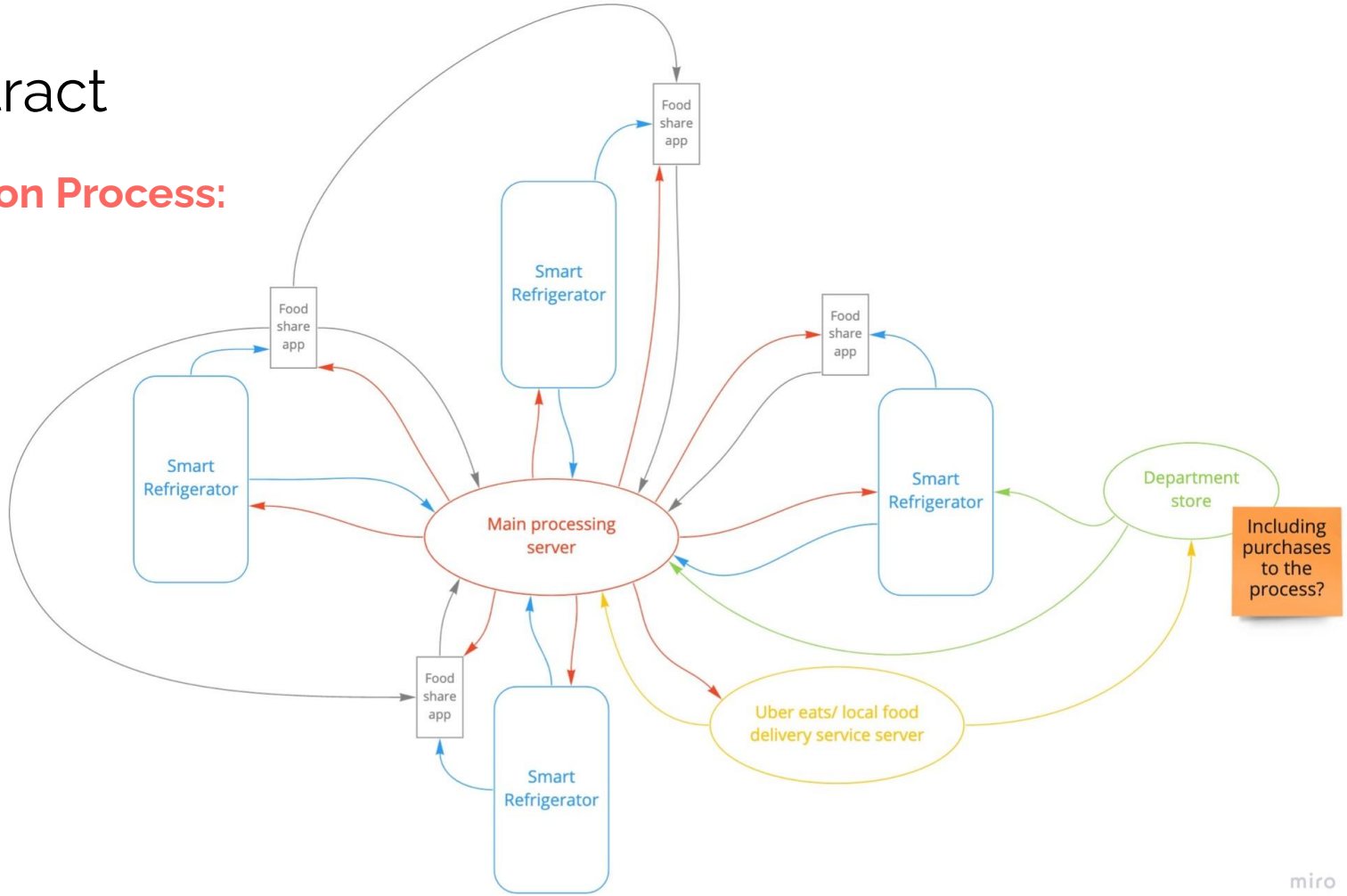
Abstract

Ideation Process:



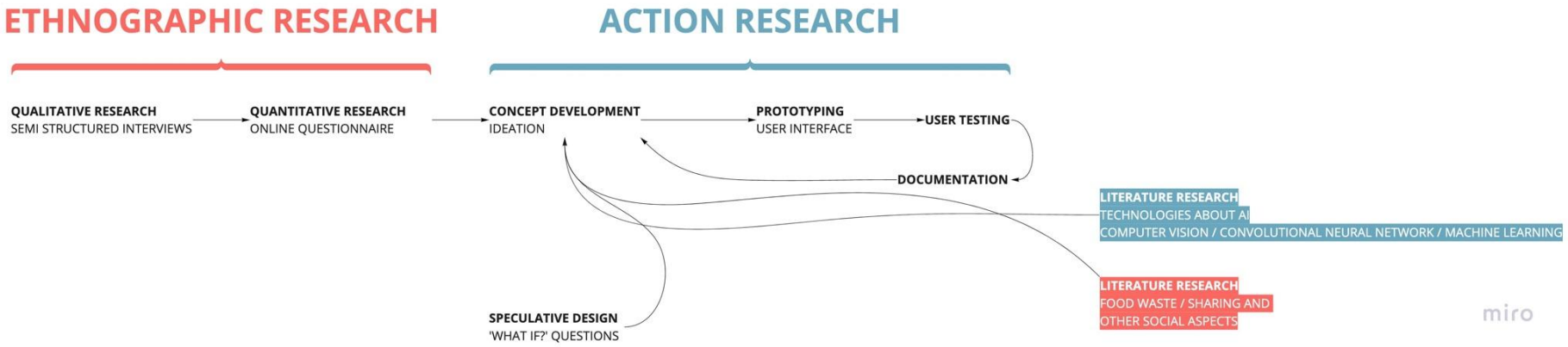
Abstract

Ideation Process:



Abstract

Methodology:



Abstract

Qualitative Research / Semi-structured Interview Quotes:

"Whenever I have to throw stuff, it hurts a little bit."- Anurag

"I try our best not to waste food because I know that there are people who are unable to afford them." - Nilüfer

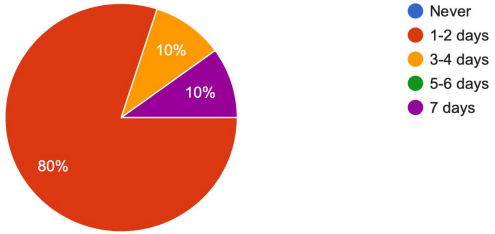
"We love sharing foods that we prepared according to new recipes with our neighbors." - Selim

Abstract

Quantitative Research:

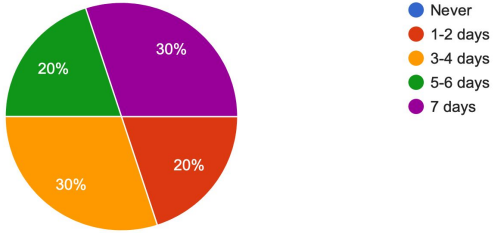
How frequently do you go groceries shopping in a week?

10 yanıt



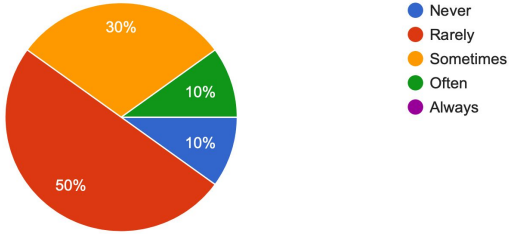
How many days a week do you or someone in your household cook your own meals?

10 yanıt



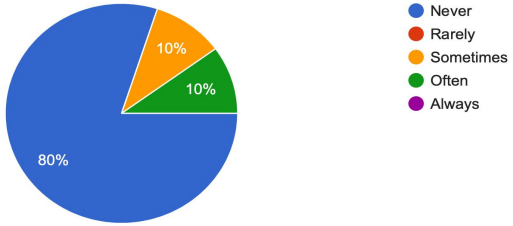
How often do you throw away food because its expiry date has passed or it got spoilt?

10 yanıt



How often do you give a food item that is about to go bad away to someone outside your household?

10 yanıt

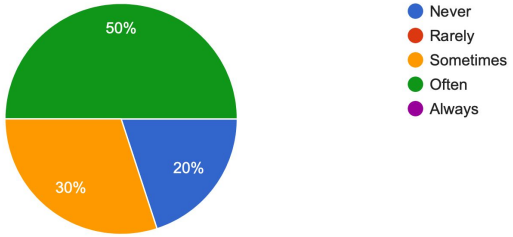


Abstract

Quantitative Research:

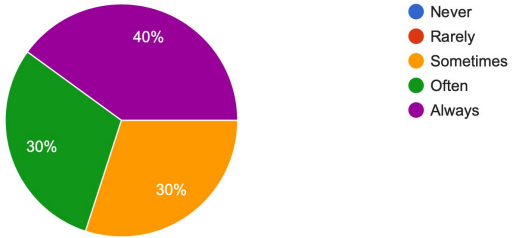
How often would you give a food item away that is about to go bad if you were to get a discount, a partial refund or another benefit or reward?

10 yanıt



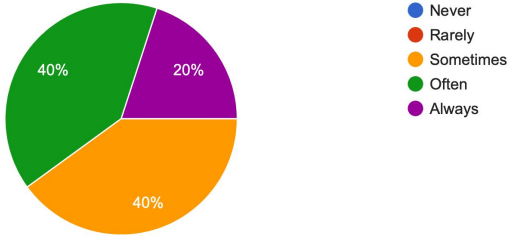
How important do you think your actions are on other people and the environment in terms of food waste?

10 yanıt



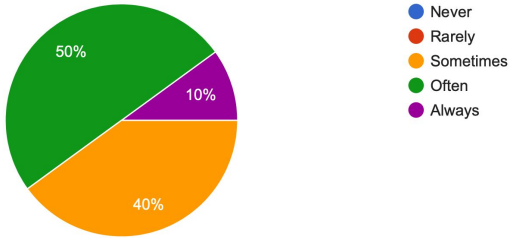
How often would you give a food item away that is about to go bad if you did get a feedback on the impact of that action on others and the environment?

10 yanıt



How often would you give a food item away that is about to go bad if it were much convenient?

10 yanıt

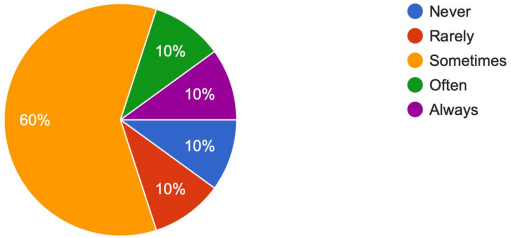


Abstract

Quantitative Research:

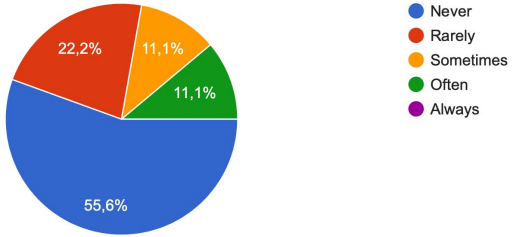
How often would you share a food item with someone if they were to bring something you actually needed in return?

10 yanıt



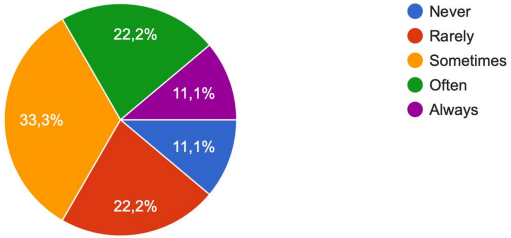
How often do you share food with your neighbours?

9 yanıt



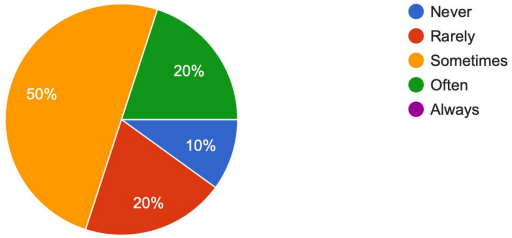
How often would you share food with your neighbours if it helped you to reduce your food waste?

9 yanıt



How often would you share food with people you don't know if it helped you to reduce your food waste?

10 yanıt



UNIT BREAKS

U2 | Applied AI Design

DETECTION

Determine food items about to expire through **Machine Learning** on;

- ➔ **Classification** to determine items
- ➔ **Regression** to determine quantities
- ➔ **Clustering** to determine items categories (fruits, legumes, etc.)

PREDICTION

Predict possible future incidents of food waste occurring through;

- ➔ Analysis of user habits on food purchases and waste

`Predict food items before expiry through;

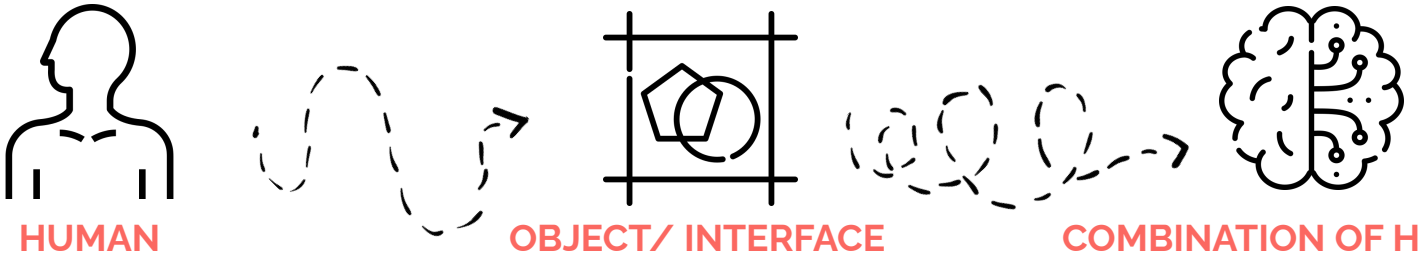
- ➔ Comparison between purchase date and shelf-life

GENERATION

Generate solutions to reduce food waste through;

- ➔ Shopping suggestions based on previous purchases and the waste patterns to reduce waste
- ➔ Suggesting recipe options to make with the expiring item(s)
- ➔ Suggesting to exchange an item with a neighbor
- ➔ Suggesting return to a store's 'about to expire' discount section
- ➔ Organize potluck meetings with neighbors

U3 | Human Interaction with AI through Service and Product Design



HUMAN PERSPECTIVE

Emotionally people feel guilty about wasting food. They are generally aware of the consequences of their actions and their responsibilities. They try to avoid food waste by the perspectives they gained from their **previous experiences.** But this requires micromanagement of every food items journey from the grocery store to their fridges and to either consumption or waste. The **social context** of food waste motivates people to avoid it.

OBJECT/ INTERFACE PERSPECTIVE

The **affordances** of food items inherently contain information regarding their edibility and shelf life most of the time. The **intrinsic factors** in terms of visual clues and/or the scents the food items inform the user if they are usable or not. However **extrinsic factors** of these food items in the way that they're hidden from view deep in fridges create a **communication problem between objects and humans** by blocking the flow of information.

COMBINATION OF HUMAN & OBJECT PERSPECTIVES

The concept aims to integrate food sharing to a **Cultural Environment** by acting as a **Boundary objects** between people and food items to increase communication from food items to users and between different people to create a new **form of interaction** by **mediating communication** between people to increase their efficiency to collaborate for the purpose to decrease food waste.

U4 | Storytelling with Data

DATA

Internet of Things
Data related to food items, their quantities, entry dates and their expiry conditions are collected from smart fridges.

Purchase Data
Grocery shopping date of users collected upon consent.

INFORMATION

Analysis and Visualisation
Data gathered is analyzed and visualized and narrated for the user about the food items that they have in stock. AI generates suggestions to make us of these stocks to avoid waste.

KNOWLEDGE

Altering User Behaviour to create knowledge on ways to make us of most of the food items purchased, ways to interact and socialize with others with food sharing and helping them make better shopping decisions to reduce waste.

WISDOM

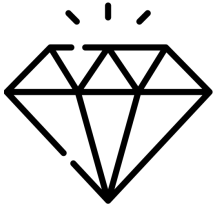
Creating Habits on the user by regular use of the platform to result in wiser habits of food purchases, food sharing and using food as a social agent.

U5 | AI Strategies for Customer Engagement and Experience

BIASES & ASSUMPTIONS

The concept aims to help **human decision-making** with biases that are aligned with ethical biases of the users to create less food waste, reduce ecological footprints and increase socialization through a **human-AI experience** that helps users to act upon these biases.

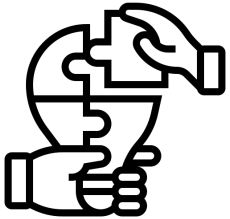
The concept aims to **engage users** in a more **aware and responsible informed decision making process.**



VALUES

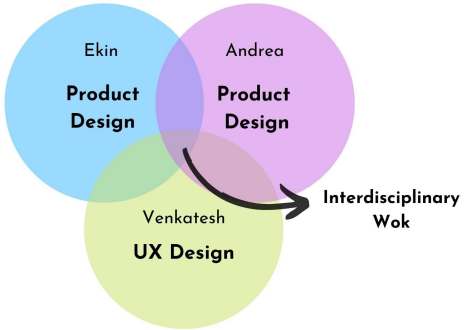
The concept aims to compliment **individual and collective social norms** within the society to create a more just system to support people who are unable to reach food and reduce waste. Since values can also be **learnt through experience**, the concept is aiming to solidify these values by supporting the acts motivated by them by creating a **value led human-AI experience.**

U6 | Social AI: Interdisciplinary Team Interaction



CO-DESIGN

The current society paradigm encouraged us to develop concepts through a new ecosystem where **human and non-human agents** are seen as equal. This interaction is a fruitful combination, in which the different backgrounds of the group members and the non-human skills resulted into a creative solution to our project.

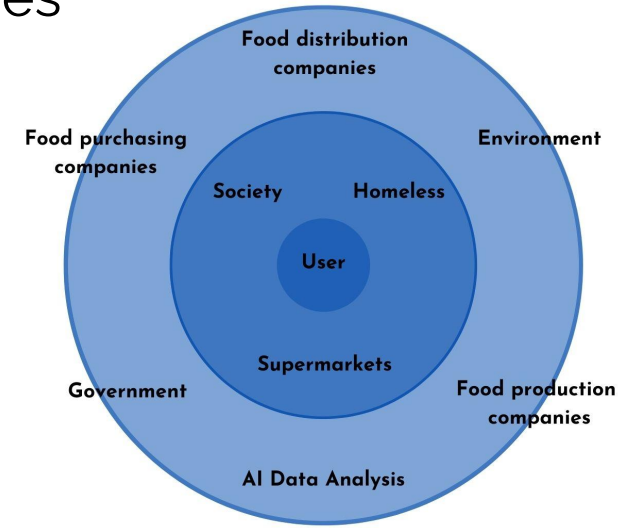


In order to share our ideas optimally, we have had discussions where each participant exposed his point of view of every aspect of the project. Also, to make that communication easier and more fluently, we have used new **collaborative platforms** of sharing information (MIRO) and online meeting platforms (Teams). These technologies have allowed us to develop new group skills as teamwork or empathy, that could not be possible without AI.

U7 | Artificial Intelligence in Design Industries

ECO-SYSTEM

During this unit we have learnt that each company should have a **scope** for **improvement**. This involve thinking about the future expansion of the company and which groups, entities… can be benefited from our project. In order to identify correctly this scope, is important to go a step back and understand the matter of our company, remember its main goal and philosophy and understanding the ecosystem where our company takes place.

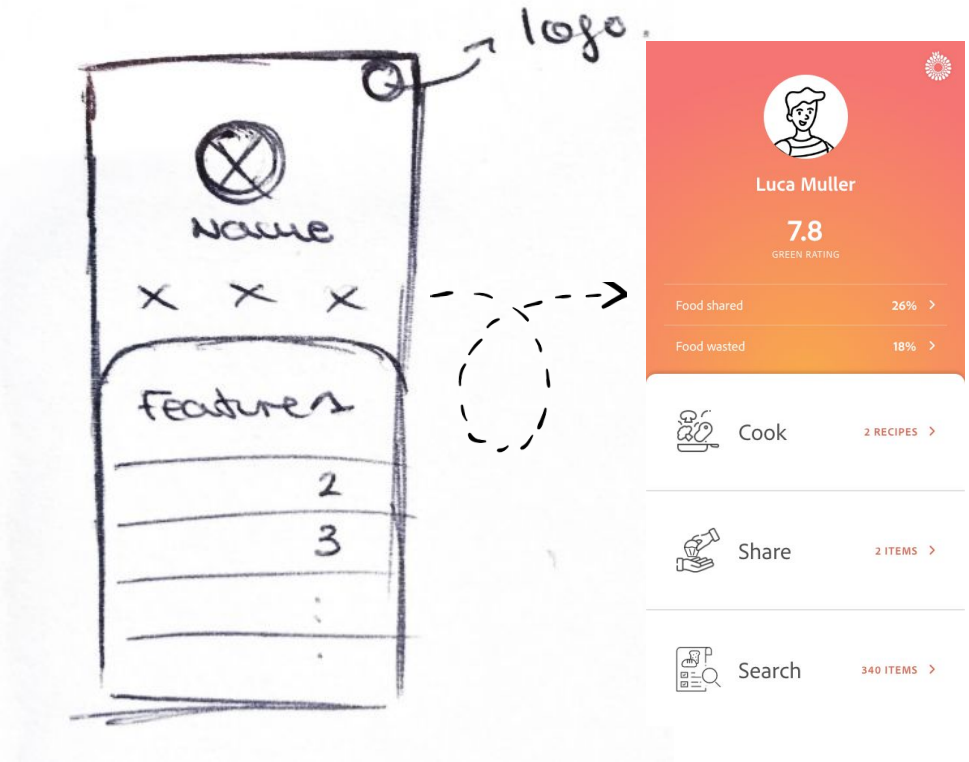


This ecosystem might involve humans, technology and other factors as materials that promote innovation. In our project, the main industries we found to expand our scope are all kind of companies related to **food production, distribution and purchasing**.

U8 | Prototyping as a Thinking Method

Prototyping allows us to **foresee** issues or consequences that could not be seen as a concept solution, as well as obtaining feedback from potential users.

At our project, we have found that creating a physical prototype doesn't make sense, as it would be necessary to use some specific technology not easy to get so, we have decided to create a **low prototype**, firstly, by sketching how should the product concept look when the users interact at the main steps of the process and, then, implementing it through Figma. The main challenge of this final step has been making the product as much intuitive to the user in order to make the **experience** as **engaging** as possible.



PROJECT DESCRIPTION

Project Description

How AI has been used?

AI technologies has been used in;

- ➔ **Internet of Things** Smart Fridges to use **'Image Search'** and **'Image Recognition'** AI trough **'Deep Learning Artificial Neural Network'** determine food items about the expire
- ➔ AI to come up with solutions such as donating about-to-expire items, exchange items with neighbors, organize potlucks
- ➔ AI to implement future shopping suggestions to reduce waste

Project Description

How the interdisciplinary context has been deployed? The concept has been developed as a **product,** that consists of an app, which provides designed **services** via user engagement with technology and AI through **user experience**. The process is backed by **design research**.

What is the innovation this project can bring to the context of the study? The project aims to innovate in the **lifecycle of food** items by informing users in more intuitive ways to reduce waste, increase sharing and social interaction.

Project Description

What theme has the project addressed? The project addressed the major theme of **'Future of Food'**.

How has the project developed the theme, and is there any particular subtheme the group has focused on? The project addressed the theme in consideration of aspects from subthemes such as **'Future of Waste'** and **'Future of Socialization'** to create more available food for people who are unable to reach it and socialization as a motivating factor and an added value.

Project Description

Who is the audience of this project? The audience is everyone **who wants to become more aware and more productive** of the food they purchase.

Who can benefit from the project and how? **People who reduce their food wastes** would benefit by the reduction of their waste, by an improved awareness and conscious and more social interactions with others. Also **people in need** would be able to reach food more easily.

Project Description

Data Sources:

DATA SOURCES

- **AI 'Detection'** to determine food items that are bought together through **ML** on;
  - **'Classification'** to determine items
  - **'Regression'** to determine quantities
  - **'Clustering'** to determine items purchased together

- **AI 'Prediction'** to determine **'Collective Behavior'** on combinations of food items
- **AI 'Generation'** to come up with recipes with any given combination of food items

- **'Internet of Things'** Smart Fridges to use **'Image Search' AI** trough **'Deep Learning Artificial Neural Network'** determine food items about the expire

- Data from grocery purchases through online or physical stores

ETHNOGRAPHIC RESEARCH

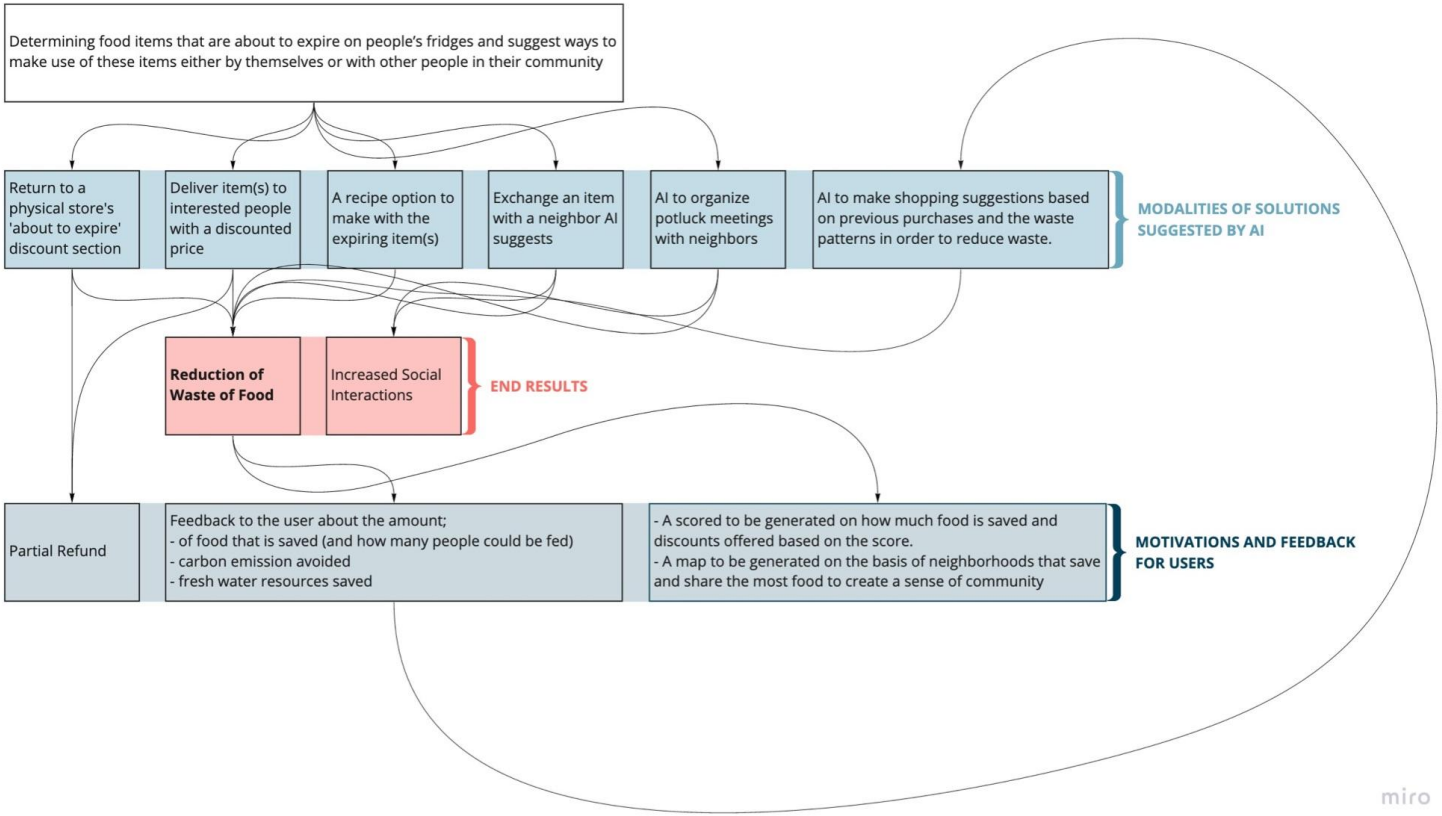
QUALITATIVE RESEARCH
Semi Structured Interviews

QUANTITATIVE RESEARCH
Online Questionnaire

Determining food items that are about to expire on people's fridges and suggest ways to make use of these items either by themselves or with other people in their community

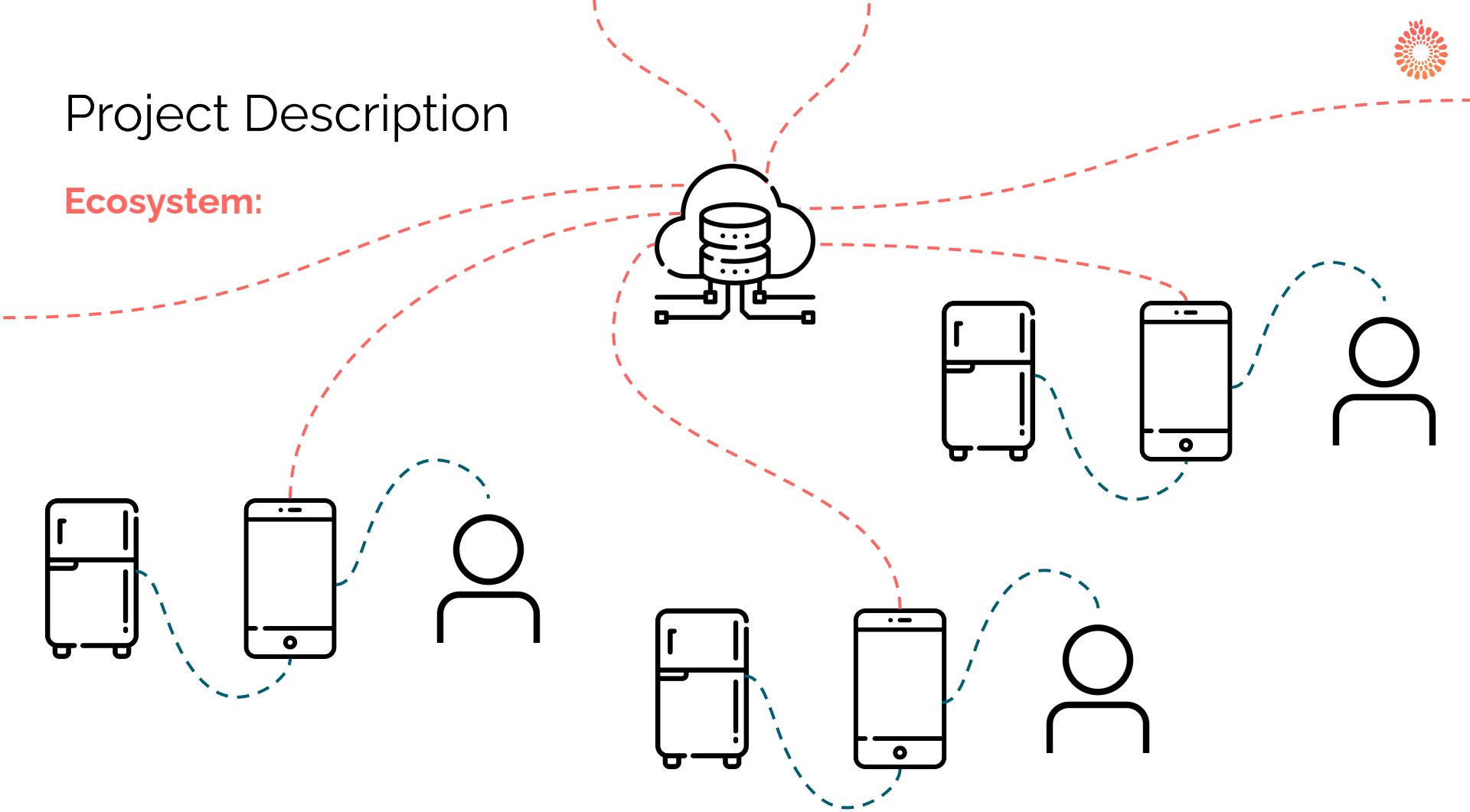
Project Description

System Architecture:



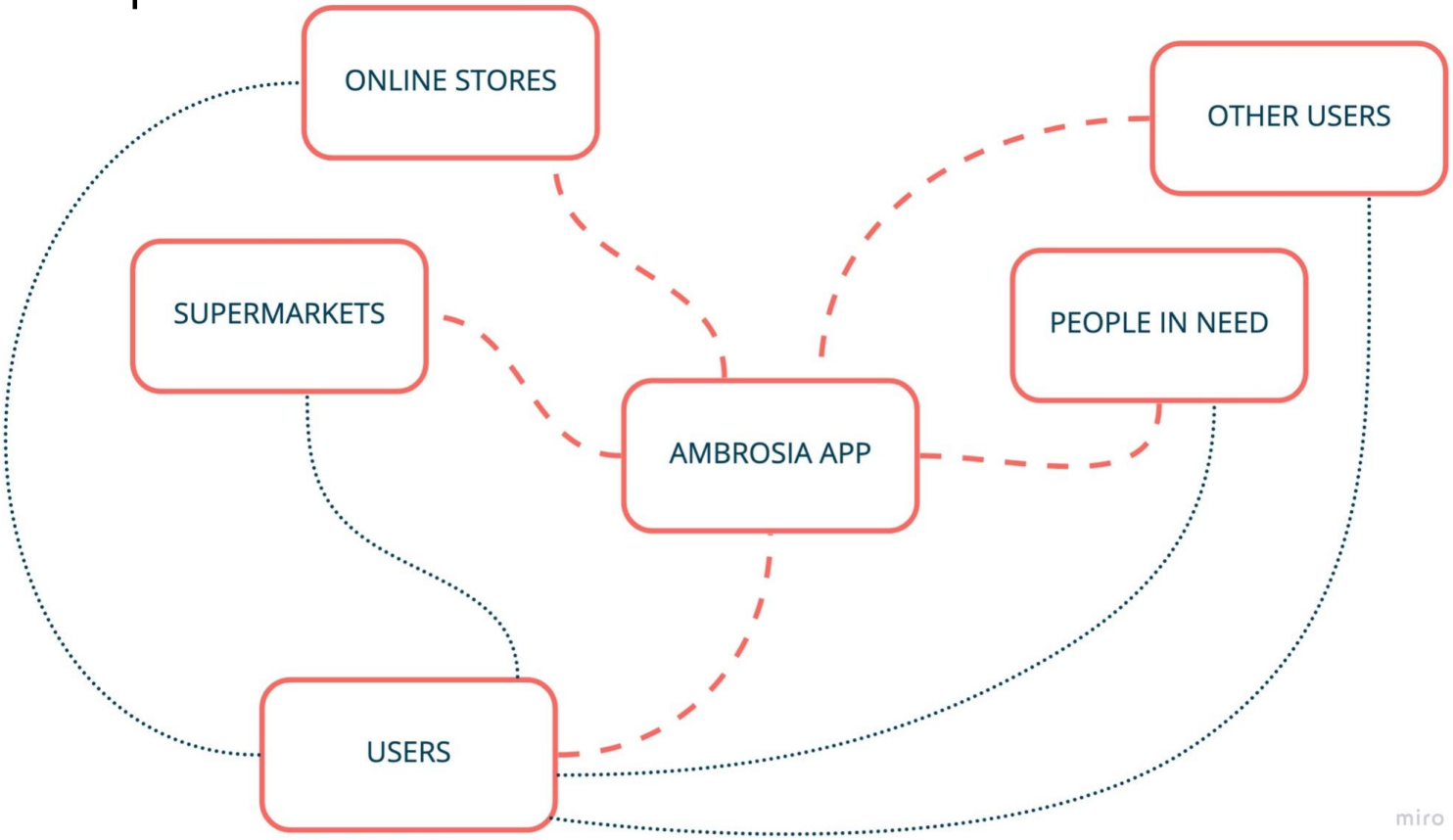
Project Description

Ecosystem:



Project Description

Stakeholder Network:



Ambrosia

Luca Muller

7.8

GREEN RATING

Food shared 26%

Food wasted 18%

Cook 2 RECIPES

Share 2 ITEMS

Search 340 ITEMS

Cook

2 RECIPES

Greek fish curry 30 MINS

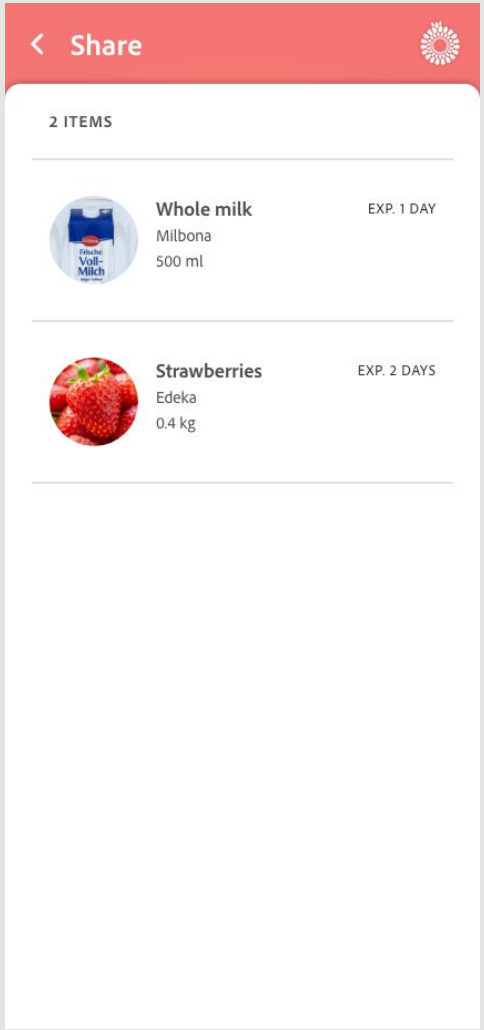
All ingredients available

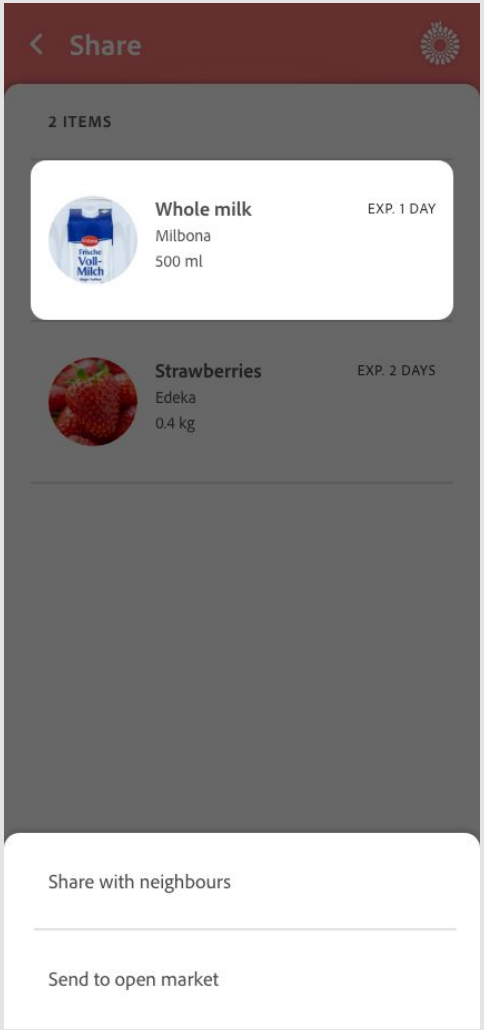
FULL RECIPE

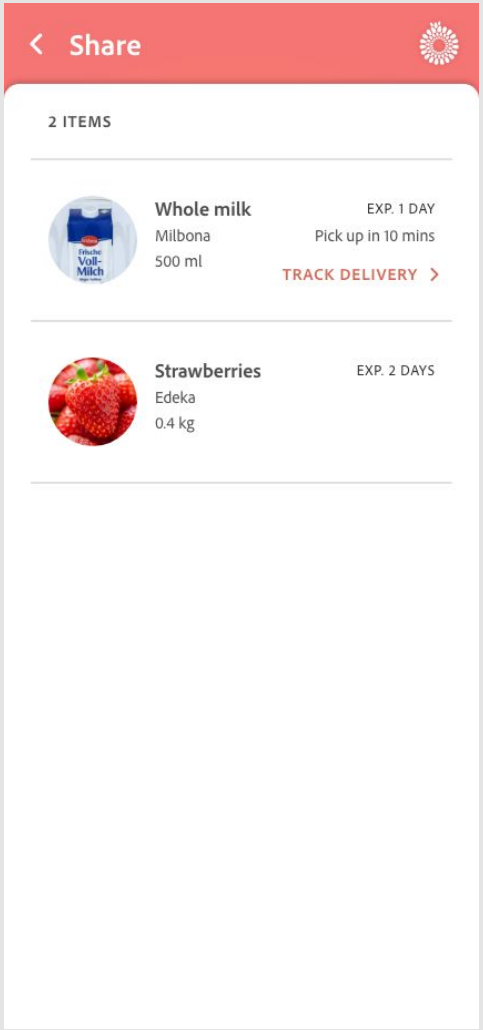
Frittatas 45 MINS

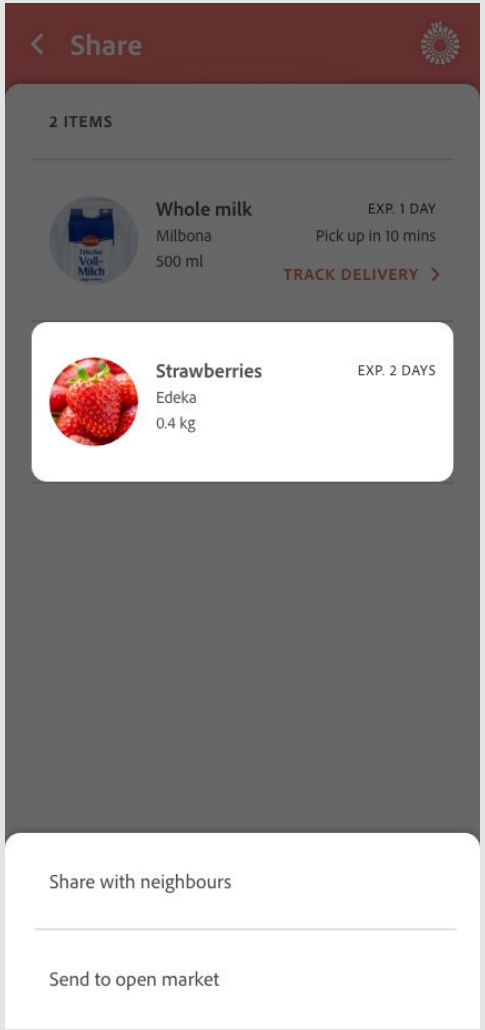
1 ingredient missing

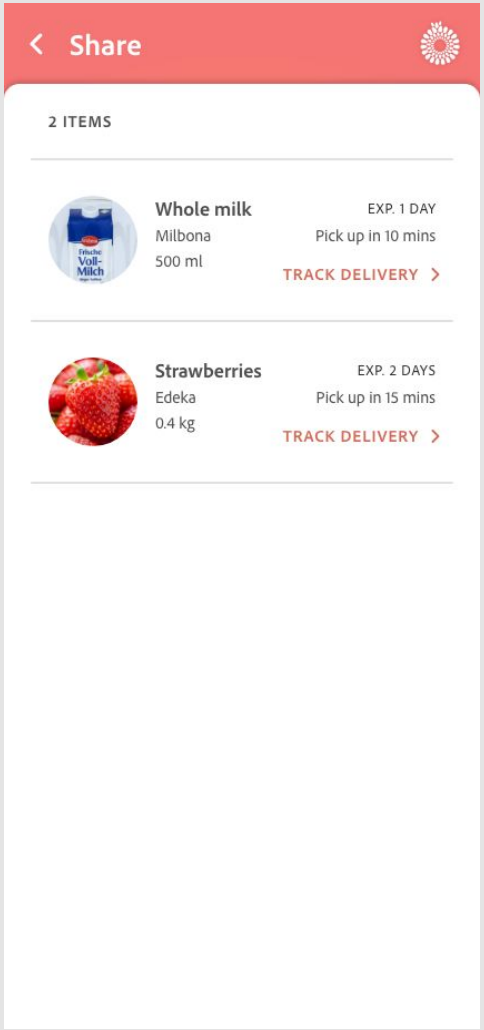
FULL RECIPE

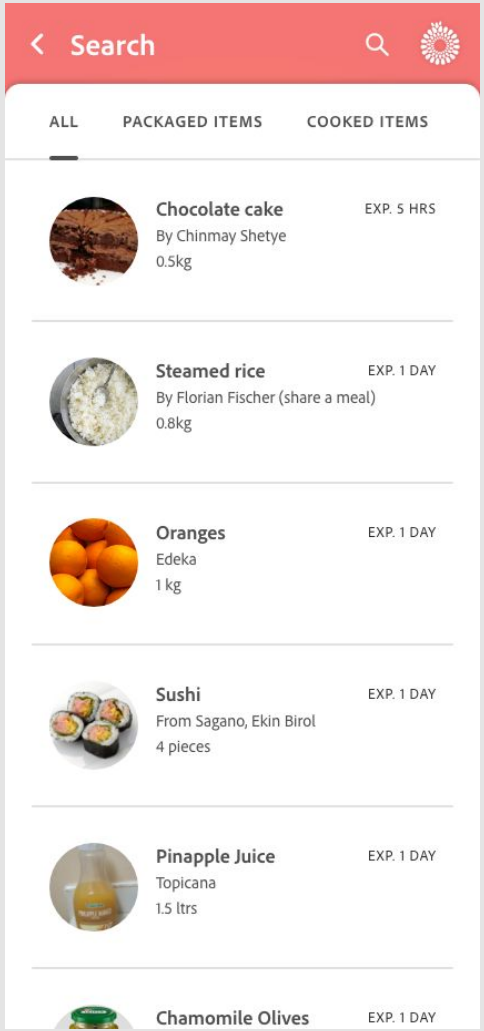

Share
2 ITEMS
Whole milk
Milbona
500 ml
EXP. 1 DAY
Strawberries
Edeka
0.4 kg
EXP. 2 DAYS

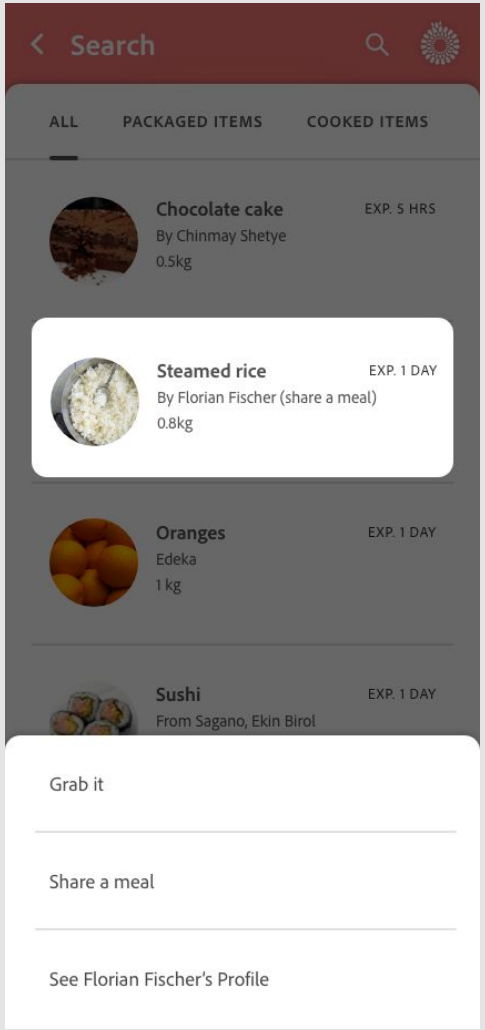

Share
2 ITEMS
Whole milk
Milbona
500 ml
EXP. 1 DAY
Strawberries
Edeka
0.4 kg
EXP. 2 DAYS
Share with neighbours
Send to open market


Share
2 ITEMS
Whole milk
Milbona
500 ml
EXP. 1 DAY
Pick up in 10 mins
TRACK DELIVERY
Strawberries
Edeka
0.4 kg
EXP. 2 DAYS


Share
2 ITEMS
Whole milk
Milbona
500 ml
EXP. 1 DAY
Pick up in 10 mins
TRACK DELIVERY
Strawberries
Edeka
0.4 kg
EXP. 2 DAYS
Share with neighbours
Send to open market

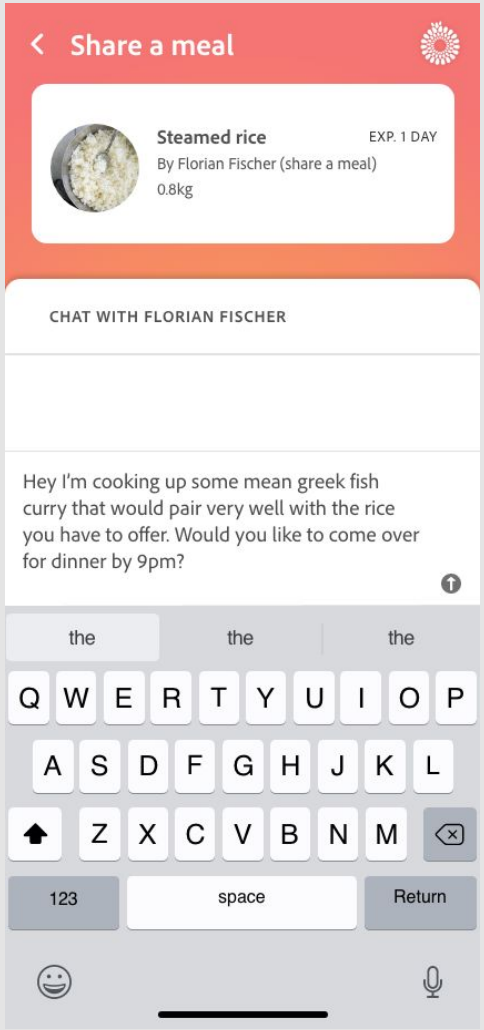

Share
2 ITEMS
Whole milk
Milbona
500 ml
EXP. 1 DAY
Pick up in 10 mins
TRACK DELIVERY
Strawberries
Edeka
0.4 kg
EXP. 2 DAYS
Pick up in 15 mins
TRACK DELIVERY

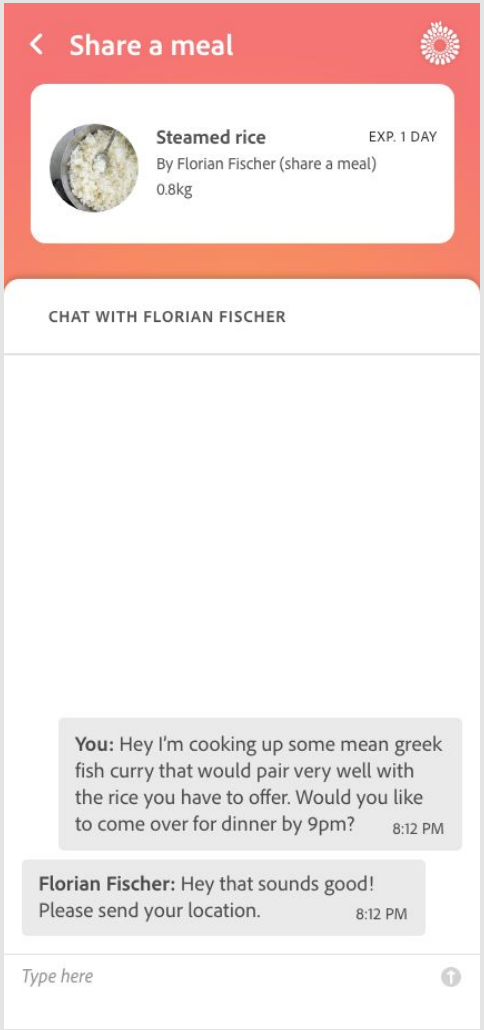

Search
ALL
PACKAGED ITEMS
COOKED ITEMS
Chocolate cake
By Chinmay Shetye
0.5kg
EXP. 5 HRS
Steamed rice
By Florian Fischer (share a meal)
0.8kg
EXP. 1 DAY
Oranges
Edeka
1 kg
EXP. 1 DAY
Sushi
From Sagano, Ekin Birol
4 pieces
EXP. 1 DAY
Pinapple Juice
Topicana
1.5 ltrs
EXP. 1 DAY
Chamomile Olives
EXP. 1 DAY

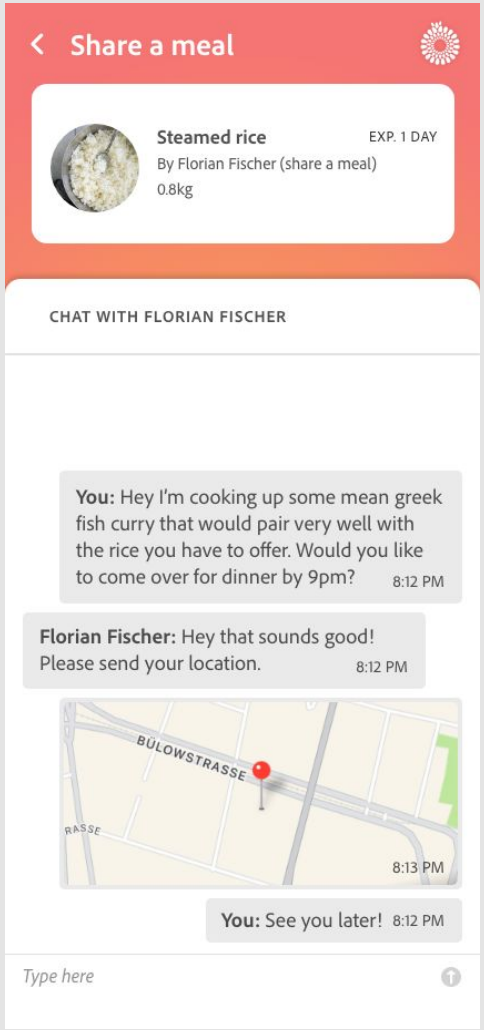

Search
ALL
PACKAGED ITEMS
COOKED ITEMS
Chocolate cake
EXP. 5 HRS
By Chinmay Shetye
0.5kg
Steamed rice
EXP. 1 DAY
By Florian Fischer (share a meal)
0.8kg
Oranges
EXP. 1 DAY
Edeka
1 kg
Sushi
EXP. 1 DAY
From Sagano, Ekin Birol
Grab it
Share a meal
See Florian Fischer's Profile

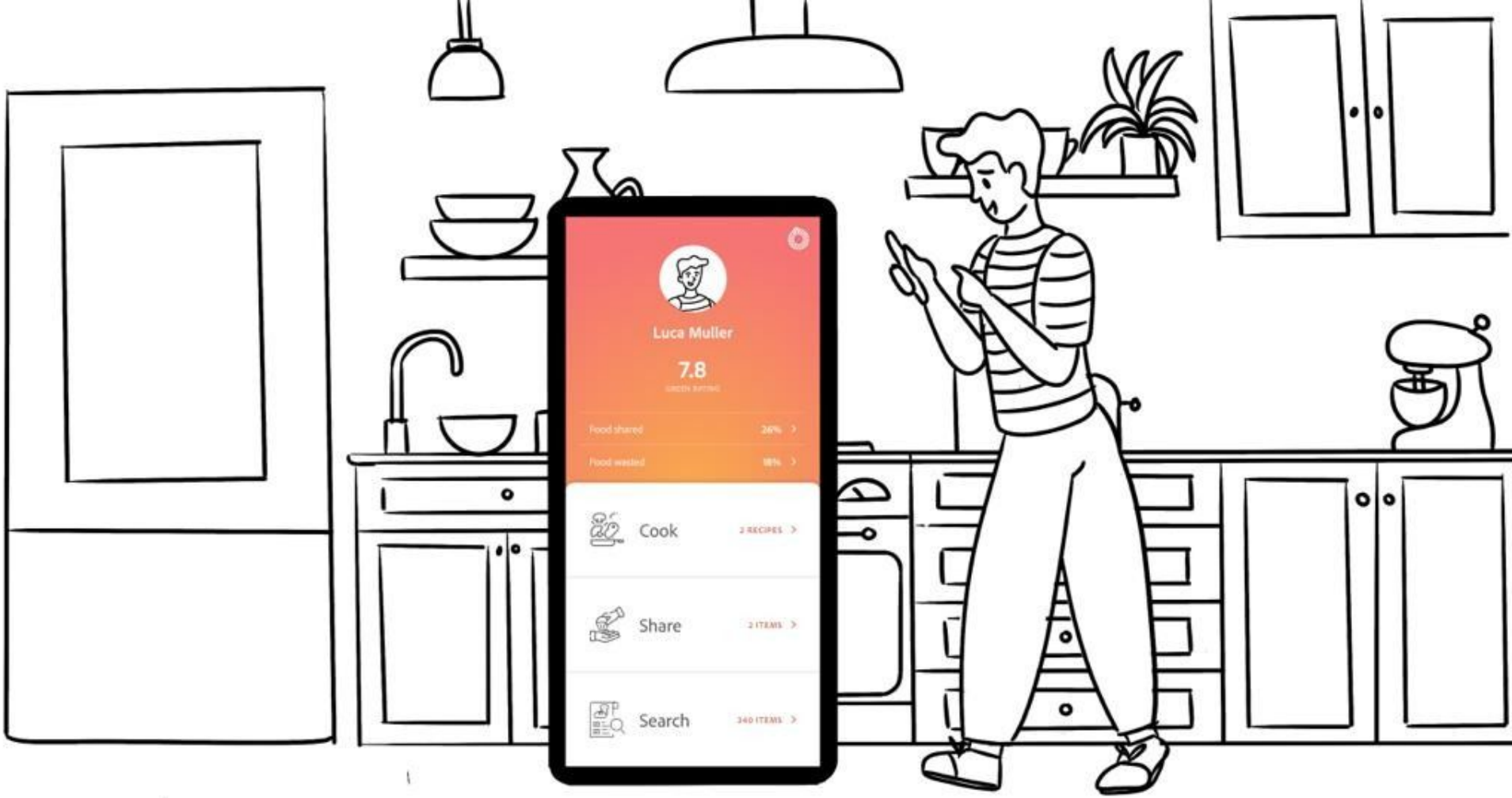

Florian Fischer
8.3
GREEN RATING
Food shared
48%
Food wasted
9%
Meals shared
23
Steamed rice
EXP. 1 DAY
By Florian Fischer (share a meal)
0.8kg


Florian Fischer
8.3
GREEN RATING
Food shared
48%
Food wasted
9%
Meals shared
23
Steamed rice
EXP. 1 DAY
By Florian Fischer (share a meal)
0.8kg
Grab it
Share a meal


Share a meal
Steamed rice
EXP. 1 DAY
By Florian Fischer (share a meal)
0.8kg
CHAT WITH FLORIAN FISCHER
Hey I'm cooking up some mean greek fish curry that would pair very well with the rice you have to offer. Would you like to come over for dinner by 9pm?
the
the
the
Q W E R T Y U I O P
A S D F G H J K L
Z X C V B N M
123
space
Return


Share a meal
Steamed rice
EXP. 1 DAY
By Florian Fischer (share a meal)
0.8kg
CHAT WITH FLORIAN FISCHER
You: Hey I'm cooking up some mean greek fish curry that would pair very well with the rice you have to offer. Would you like to come over for dinner by 9pm? 8:12 PM
Florian Fischer: Hey that sounds good! Please send your location. 8:12 PM
Type here


Share a meal
Steamed rice
EXP. 1 DAY
By Florian Fischer (share a meal)
0.8kg
CHAT WITH FLORIAN FISCHER
You: Hey I'm cooking up some mean greek fish curry that would pair very well with the rice you have to offer. Would you like to come over for dinner by 9pm? 8:12 PM
Florian Fischer: Hey that sounds good! Please send your location. 8:12 PM
BÜLOWSTRASSE
8:13 PM
You: See you later! 8:12 PM
Type here


Luca Muller
7.8
Food shared
26%
Food wasted
18%
Cook
2 RECIPES
Share
2 ITEMS
Search
340 ITEMS

ANNOTATED BIBLIOGRAPHY & REFERENCES

Annotated Bibliography

Food Waste / Sharing & Social Aspects

part of the SP Group

Global Food Losses and Food Waste

Save Food Congress, Düsseldorf 16 May 2011

Jenny Gustavsson, Christel Cederberg & Ulf Sonesson
SIK – The Swedish Institute for Food and Biotechnology

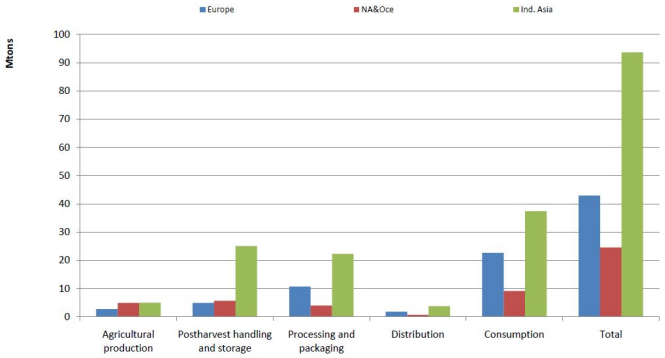
How to prevent food waste?

- ➔ *Improved communication in supply chains*
- ➔ *Awareness*
- ➔ *Consumer power*
- ➔ ***Improved purchase and consumption planning***
- ➔ *Education (best-before-dates)*

Volumes of waste

part of the SP Group

Example cereals:



Total:
Europe: 40-45 Mton – 57 billion USD
North America & Oceania: 23-37 Mton – 33 billion USD
Industrialized Asia: 90-95 Mton – 29 billion USD

Annotated Bibliography

Food Waste / Sharing & Social Aspects

Rivista di Economia Agraria, Anno LXIX, n. 2-3, 2014: 201-209

Francesco Marangon,
Tiziano Tempesta,
Stefania Troiano,
Daniel Vecchiato

Dipartimento di Scienze Economiche e Statistiche, Università degli Studi di Udine
Dipartimento del Territorio e Sistemi Agro-Forestali, Università degli Studi di Padova

Food waste, consumer attitudes and behaviour. A study in the North-Eastern part of Italy

Keywords: food waste, sustainable consumption, modern lifestyle
JEL Codes: Q01, P46

Reducing the amount of wasted food is a key element in developing a sustainable food system.
Large quantities of produced food are discarded and, to a large extent, the waste is avoidable. The wastage of food occurs at all stages of the food life cycle, starting from harvesting, through manufacturing and distributing and finally consumption, but the largest contribution to food waste occur at home.
In the past, several studies investigated the amount of food waste in Italy. Nevertheless there is a substantial lack in the knowledge of the reasons linked to waste food at households.
The aim of this paper is to focus on the consumption food waste for exploring the reasons of food waste on family level, which is a significant fraction of total, in order to overcome food wasting behaviour and point out options to design prevention measures.

1. Introduction

During recent years there has been increasing international interest in the amount of wasted food and its negative consequences. Reducing the amount of food that is wasted is a key element in developing a sustainable food system. In fact, firstly, food waste represents a monetary loss, secondly, has a social impact as it contributes towards increases in food prices, making food less accessible for the poorest and increasing the number of malnourished people (Graham-Rowe et al., 2014; Stuart, 2009), thirdly, contributes to decreasing the quality level of natural resources generating also greenhouse gasses (FAO, 2013 and 2014; WRAP, 2011).

Recently the question of the adverse environmental impact of food waste has shifted from being something of interest to a selected group of researches only, to a position at the centre of public and institutional attention. This is due to the diffusion of more precise information about the economic, social and environmental impacts of the increasing amounts of food wasted especially in the industrialized countries.

The aim of this study is to explore reasons for household food waste with special attention to food waste that can be related to households' behavior, purchase habits, attitudes and life style.

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ISSN (print): 0035-6190
ISSN (online): 2281-1559

"As expected based on previous research (Stefan et al., 2013), ***planning and shopping routines are important predictors of food waste behavior."*** *p206*

"Highlighting the benefits of reducing household food waste by ***providing more information could support people to reduce food waste."*** *p207*

"If ***dialogue can stimulate new thoughts and encourage people to act more altruistically*** *(Refsgaard and Magnussen, 2009) it could be useful to increase co-operation between food value-chain actors." p207*

Tab. 1. Estimated model explaining waste food probability in the home

Variable	B	E.S.	Wald	df	Sig.	Exp(B)
I think that waste is an important problem	-0,992	0,325	9,305	1,000	0,002	0,371
Too big packages	0,639	0,229	7,787	1,000	0,005	1,894
Under age 31	1,175	0,461	6,491	1,000	0,011	3,239
Age 31 - 45 years	1,219	0,467	6,813	1,000	0,009	3,383
Age 46 - 60 years	1,055	0,449	5,513	1,000	0,019	2,871
Family size	0,208	0,102	4,108	1,000	0,043	1,231
Years of education	0,097	0,035	7,774	1,000	0,005	1,102
Supermarket and hypermarket shopping	0,638	0,342	3,479	1,000	0,062	1,893
Once-a-week shopping	0,359	0,206	3,019	1,000	0,082	1,431
Food purchase: more than € 100,00	0,474	0,214	4,902	1,000	0,027	1,607
Constant	-3,586	0,757	22,428	1,000	0,000	0,028

Right predicted percentage		Predicted		
		Yes waste		Right percentage
		0,00	1,00	
Yes waste	0,00	209	64	76,6
	1,00	103	97	48,5
Global percentage			64,7	

-2 log likelihood	Cox and Snell R-squared	Nagelkerke R-squared
580.165	0,13	0,17

Annotated Bibliography

Food Waste / Sharing & Social Aspects

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Journal of Cleaner Production

journal homepage: www.elsevier.com/locate/jclepro

Food waste matters - A systematic review of household food waste practices and their policy implications

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Food behaviour
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Food policy
Sustainable consumption

ABSTRACT

In recent years, food waste has received growing interest from local, national and European policy-makers, international organisations, NGOs as well as academics from various disciplinary fields. Increasing concerns about food security and environmental impacts, such as resource depletion and greenhouse gas emissions attributed to food waste, have intensified attention to the topic. While food waste occurs in all stages of the food supply chain, private households have been identified as key actors in food waste generation. However, the evidence on why food waste occurs remains scattered. This paper maps the still small but expanding academic territory of consumer food waste by systematically reviewing empirical studies on food waste practices as well as distilling factors that foster and impede the generation of food waste on the household level. Moreover, we briefly discuss the contributions of different social ontologies, more particularly psychology-related approaches and social practice theory. The analysis reveals food waste as a complex and multi-faceted issue that cannot be attributed to single variables; this also calls for a stronger integration of different disciplinary perspectives. Mapping the determinants of waste generation deepens the understanding of household practices and helps design food waste prevention strategies. Finally, we link the identified factors with a set of policy, business, and retailer options.

1. Introduction

Globally, nearly one third of food produced for human consumption is lost or wasted, equalling a total of 1.3. billion tonnes of food per year (Gustavsson et al., 2011). As the production of food is resource-intensive, food losses and wastes are indirectly accompanied by a broad range of environmental impacts, such as soil erosion, deforestation, water and air pollution, as well as greenhouse gas emissions that occurin the processes of food production, storage, transportation, and waste management (Mourad, 2016). Scenarios for Europe indicate a considerable potential for reducing emissions through the reduction of food waste (Rutten et al., 2013) along the stages of the food production and consumption chain (Schanes et al., 2016).

Due to these growing environmental but also social and economic concerns, food waste is increasingly acknowledged as an urgent issue among governments, businesses, NGOs, academics, and the general public. In response, there is a mounting evidence base on the quantities of food wasted and the related emissions along the food production-consumption chain (e.g. Beretta et al., 2013; Edjabou et al., 2016). Along the food supply chain, private households represent the largest food-waste faction (BIOIS, 2010). Given the high amounts of food waste occurring on the household level, the prevention of food waste at the final stages of the supply chain is of utmost importance to help prevent further climate change (Parfitt et al., 2010). To be more precise, if food is wasted by households at the end of the supply chain, all (fossil) energy (and greenhouse gas emissions) put into its production, processing, transportation, cooling and preparation was in vain.

There is, however, still a relative paucity of field research on the subject of consumer-generated food waste in the context of private households. Despite a growing number of studies, little is known about the determinants of consumer food waste and the underlying factors that encourage, drive or impede food waste behaviours and practices (Graham-Rowe et al., 2014). A closer look at households brings to light that the issues of food waste and sustainable practices around food are multifaceted (Evans, 2014). Given its complex

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"Several studies have demonstrated that ***guilt, perceived behavioural control, and negative attitudes towards food waste may predict the intention to reduce food waste*** *and/or reported food waste." p988*

*"****Lack of knowledge regarding the social and environmental consequences of food waste*** *needs to be tackled to improve people's awareness of the wider impacts of wasteful behaviour." p988*

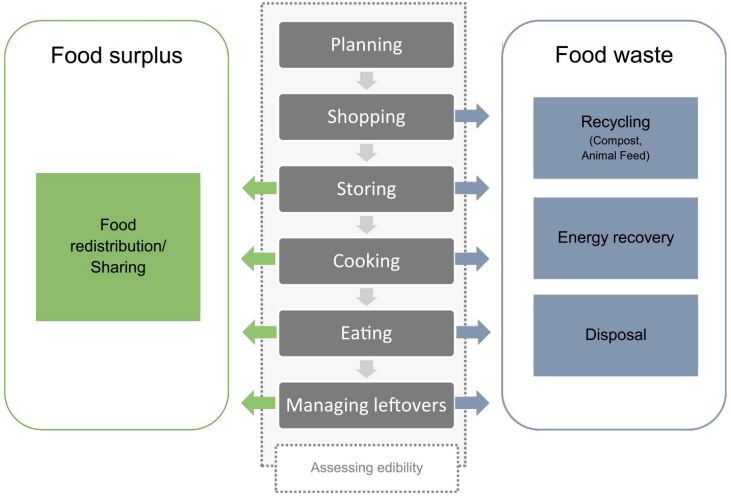

Fig. 2. Food-related practices and routines.

Annotated Bibliography

Food Waste / Sharing & Social Aspects

Sustainability **2015**, *7*, 6457-6477; doi:10.3390/su7066457

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sustainability

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Review

Consumer-Related Food Waste: Causes and Potential for Action

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Abstract: In the past decade, food waste has received increased attention on both academic and societal levels. As a cause of negative economic, environmental and social effects, food waste is considered to be one of the sustainability issues that needs to be addressed. In developed countries, consumers are one of the biggest sources of food waste. To successfully reduce consumer-related food waste, it is necessary to have a clear understanding of the factors influencing food waste-related consumer perceptions and behaviors. The present paper presents the results of a literature review and expert interviews on factors causing consumer-related food waste in households and supply chains. Results show that consumers' motivation to avoid food waste, their management skills of food provisioning and food handling and their trade-offs between priorities have an extensive influence on their food waste behaviors. We identify actions that governments, societal stakeholders and retailers can undertake to reduce consumer-related food waste, highlighting that synergistic actions between all parties are most promising. Further research should focus on exploring specific food waste contexts and interactions more in-depth. Experiments and interventions in particular can contribute to a shift from analysis to solutions.

"The first one is that economic constraints and price orientation traditionally, and to a renewed extent during the economic crisis, are drivers of food waste avoidance both in the store, as well as in the household. These drivers might also ***motivate alternative behaviors, such as sharing*** *and gardening." p6469*

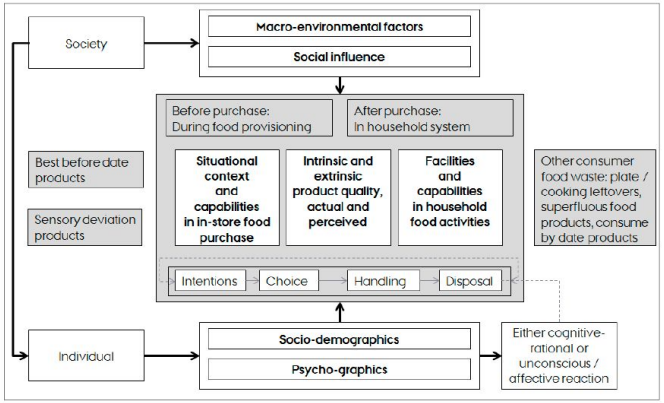

Figure 1. Model of the factors of influence on consumer-related food waste.

"The alternative behaviors go further beyond mere financial considerations, in that the ***food waste avoidance practices might be part of a lifestyle and a consumer's identity****: consumers might take pride in being a smart shopper or thrifty household manager, enjoy the creative process of tackling leftovers or develop their i****dentity via the formation of social relations*** *in grass-roots networks" p6469*

Annotated Bibliography

Technologies about AI / Computer Vision / Convolutional Neural Network / Machine Learning

Journal of Agriculture and Food Research 2 (2020) 100033

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Journal of Agriculture and Food Research

journal homepage: www.journals.elsevier.com/journal-of-agriculture-and-food-research/

A critical review on computer vision and artificial intelligence in food industry

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ARTICLE INFO

Keywords:
Computer vision
Artificial intelligence
Sustainable food supply
Autonomous navigation

ABSTRACT

Emerging technologies such as computer vision and Artificial Intelligence (AI) are estimated to leverage the accessibility of big data for active training and yielding operational real time smart machines and predictable models. This phenomenon of applying vision and learning methods for the improvement of food industry is termed as computer vision and AI driven food industry. This review contributes to provide an insight into state-of-the-art AI and computer vision technologies that can assist farmers in agriculture and food processing. This paper investigates various scenarios and use cases of machine learning, machine vision and deep learning in global perspective with the lens of sustainability. It explains the increasing demand towards the AgTech industry using computer vision and AI which might be a path towards sustainable food production to feed the future. Also, this review tosses some implications regarding challenges and recommendations in inclusion of technologies in real time farming, substantial global policies and investments. Finally, the paper discusses the possibility of using Fourth Industrial Revolution [4.0 IR] technologies such as deep learning and computer vision robotics as a key for sustainable food production.

1. Introduction

In recent times, the world has gone through various speculations regarding food production and factors that influence commodity markets in a demand-supply chain. These insights have raised severe concern towards mankind's capability in enduring such food demand and sustainability to feed the growing population. One way to look at this problem is to put a question forward asking: Is it possible to deal with this situation without further exploiting world's resources and damaging environment? Numerous factors show up while answering these questions. Issues such as radical growth in the world's population, gradual raising income levels in developing countries, global warming and other environment hazards caused by mankind over a span of decades. Specifically, the demand in growth for food supplies invokes equivalent production values and sustainable methods. With growing population in the rise, the Food and Agricultural Organization (FAO) of United Nations stated that this population can reach around 9.1 billion by 2050 [35]. Thoroughly, this estimate throws a torch on need for compensating rise in food supply by 70% worldwide and nearly double in developing countries [2]. The term "undernourishment" - inability to acquire enough food and level of insufficient food intake in order to meet the required dietary energy requirements is still a problem [42].

According to FAO, 793 million people-one in every nine people in the world lacks food for leading their daily life. FAO recorded data depicted in Fig. 1B illustrates the fact that few Asian countries still suffer from undernourishment. Intuitively, the two big nations India and China shares the first and second places respectively with correspondence to their growing population and economical advancements [99]. Statistically,

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"Computers now are not just able to display images of food but instead they can ***identify and reveal facts about the nutritional information of that food.*** *Taking it even further, in 2016 International Business Machines Corporation (IBM)'s AI Watson made its way into becoming first* ***AI chef through suggesting new and innovative recipes just by looking at the ingredients*** *[78]. Through its prominent feature of exhibiting variations in a recipe with similar ingredients, IBM's Watson left renowned chefs in silence"* p6

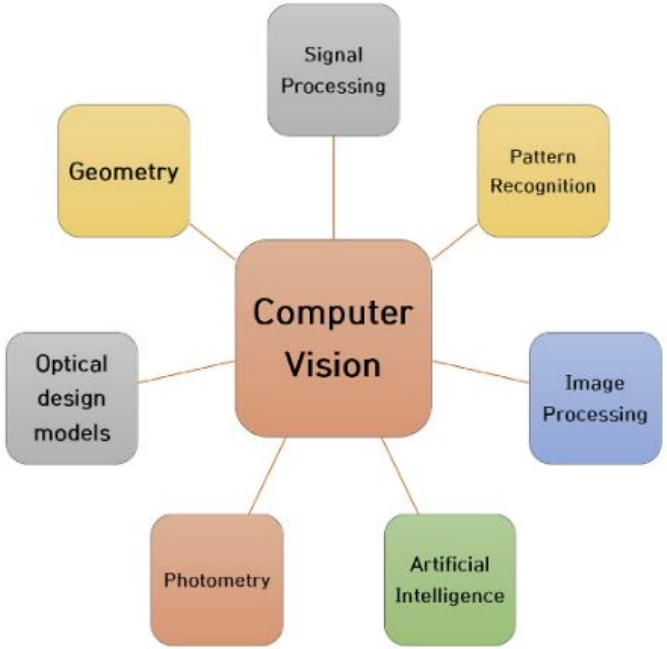

Fig. 3. Computer vision and its sub-concepts.

Annotated Bibliography

Technologies about AI / Computer Vision / Convolutional Neural Network / Machine Learning

Food Detection and Recognition Using Convolutional Neural Network

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ABSTRACT

In this paper, we apply a convolutional neural network (CNN) to the tasks of detecting and recognizing food images. Because of the wide diversity of types of food, image recognition of food items is generally very difficult. However, deep learning has been shown recently to be a very powerful image recognition technique, and CNN is a state-of-the-art approach to deep learning. We applied CNN to the tasks of food detection and recognition through parameter optimization. We constructed a dataset of the most frequent food items in a publicly available food-logging system, and used it to evaluate recognition performance. CNN showed significantly higher accuracy than did traditional support-vector-machine-based methods with handcrafted features. In addition, we found that the convolution kernels show that color dominates the feature extraction process. For food image detection, CNN also showed significantly higher accuracy than a conventional method did.

Categories and Subject Descriptors

I.5.4 [**Computing Methodologies**]: Pattern recognition—*Computer Vision*; I.2.6 [**Artificial Intelligence**]: Learning—*Connectionism and neural nets*

General Terms

Experimentation

Keywords

deep learning; food recognition; food detection; convolutional neural network

1. INTRODUCTION

Diet is very important in human life. Obtaining adequate nutrition from everyday meals is essential for our health. To know what we eat, we often make a record of everyday meals. Such food recording is usually a manual exercise using textual description, but manual recording is tedious and time consuming. To overcome this difficulty, there have been attempts to assist food recording by using information technology. Image recognition of food items would be a good solution to food recording. Taking a picture would then be a sufficient record. However, we know that there is a wide diversity of types of food. Even within the same food category, there is considerable diversity. Therefore, despite the attempts at food item recognition, recognition performance is not yet satisfactory.

Regarding food image recognition, Zhu et al. [12] described food recognition using a small dataset, which was intended to be used in a smartphone-based food-logging system as part of their Technology Assisted Dietary Assessment project. Hoashi et al. [5] examined 85 food items, achieving 62.5% accuracy for the recognition of Japanese food images collected from the Web. They used multiple kernel learning for feature fusion as their machine learning method. The Pittsburgh Fast-Food Image Dataset [4] is a dataset of American fast-food images, which was used to evaluate a food-recognition method in [11, 6]. Food balance, an aspect of nutritional content, was estimated by image processing [2]. Image retrieval was applied to food recording [1].

Deep learning has recently been used in image recognition [8]. Deep learning is a collective term for algorithms having a deep architecture that solves complex problems. The most distinctive characteristic is that better image features for recognition are automatically extracted via training. The convolutional neural network (CNN) [9] is one of the methods that satisfy the requirements of the deep learning approach. CNN is now a state-of-the-art technique for image recognition challenges such as the Large Scale Visual Recognition Challenge [7].

In this paper, we apply CNN to the recognition and detection of food images and evaluate its performance. Our contributions are as follows: (1) we built a dataset for food recognition experiments by using food-domain images obtained from a food logging system available for public use; (2) we optimized CNN's hyper parameters, showing that CNN significantly improved the food recognition accuracy compared with a conventional method using a support vector machine (SVM) with hand-crafted features; (3) through observation of our trained CNN, we found that color features dominate the food recognition process; (4) we showed that CNN has significantly better performance for the task

MM'14, November 3–7, 2014, Orlando, Florida, USA.

http://dx.doi.org/10.1145/2647868.2654970.

*"We **constructed a dataset of the most frequent food items in a publicly available food-logging system, and used it to evaluate recognition performance.** Convolutional neural network (CNN) showed significantly higher accuracy than did traditional support-vector-machine-based Methods with handcrafted features. In addition, we found that the convolution kernels show that color dominates the feature extraction process. For food image detection, CNN also showed significantly higher accuracy than a conventional method did."*

	Natto	Yogurt	Green Salad	Deep-fried chicken	Rice	Ramen	Miso soup	Grilled salmon	Cold tofu	Curry and rice
Natto	60.11%	8.33%	2.44%	5.78%	3.33%	4.00%	2.89%	2.00%	6.11%	5.00%
Yogurt	4.89%	65.89%	4.44%	2.11%	7.89%	1.44%	2.67%	1.78%	8.56%	0.33%
Green salad	1.89%	3.11%	72.11%	2.78%	2.22%	7.22%	3.33%	2.67%	3.89%	0.78%
Deep-fried chicken	4.11%	1.67%	2.56%	70.00%	0.89%	3.22%	4.56%	6.22%	3.56%	3.22%
Rice	3.89%	5.33%	2.56%	1.33%	72.78%	2.22%	2.67%	1.33%	6.56%	1.33%
Ramen	3.33%	2.44%	8.00%	3.56%	2.11%	68.22%	3.67%	2.33%	3.56%	2.78%
Miso soup	1.33%	2.22%	3.22%	2.11%	1.56%	4.00%	78.22%	0.78%	4.00%	2.56%
Grilled salmon	2.44%	3.56%	2.44%	9.11%	2.33%	3.33%	1.89%	70.22%	3.78%	0.89%
Cold tofu	5.22%	8.22%	6.00%	4.22%	7.22%	3.89%	5.56%	1.44%	54.67%	3.56%
Curry and rice	2.89%	1.00%	1.44%	4.67%	2.78%	3.44%	2.67%	0.67%	2.00%	78.44%

(a) CNN

	Natto	Yogurt	Green Salad	Deep-fried chicken	Rice	Ramen	Miso soup	Grilled salmon	Cold tofu	Curry and rice
Natto	46.34%	10.00%	1.89%	6.77%	4.56%	4.67%	4.11%	4.22%	9.67%	7.78%
Yogurt	6.34%	61.77%	3.45%	1.89%	8.22%	1.56%	2.56%	4.00%	7.67%	2.56%
Green salad	1.67%	5.11%	56.98%	3.67%	3.33%	9.78%	5.44%	3.67%	8.56%	1.78%
Deep-fried chicken	7.56%	2.33%	2.22%	47.66%	0.78%	6.00%	6.00%	6.67%	5.11%	15.66%
Rice	4.78%	9.44%	2.22%	1.44%	61.23%	2.67%	3.78%	2.22%	10.00%	2.22%
Ramen	4.12%	2.45%	8.23%	5.78%	2.45%	57.62%	6.23%	4.12%	5.67%	3.34%
Miso soup	3.22%	3.11%	4.78%	6.45%	2.11%	5.00%	60.21%	2.22%	5.78%	7.11%
Grilled salmon	6.00%	5.44%	3.89%	7.89%	2.00%	4.22%	2.78%	57.42%	8.11%	2.22%
Cold tofu	6.34%	8.00%	8.56%	6.22%	14.89%	7.67%	5.33%	4.89%	35.01%	3.11%
Curry and rice	5.33%	2.22%	1.56%	12.34%	1.67%	2.78%	5.33%	1.22%	2.78%	64.79%

(b) Color SPM + SVM

References

Kakani, V. Nguyen, V. H. Kumar, B.P. Kim, H. Pasupulet, V.R. (2020) A critical review on computer vision and artificial intelligence in food industry. *Journal of Agriculture and Food Research 2 (2020) 100033* https://doi.org/10.1016/j.jafr.2020.100033

Shen, z. Shehzad, A. Chen, S. Sun, H. Liu J. (2020) Machine Learning Based Approach on Food Recognition and Nutrition Estimation *Procedia Computer Science 174 (2020) 448–453* https://doi.org/10.1016/j.procs.2020.06.113

Kagaya, H. Aizawa, K. Ogawa M. (2014) Food Detection and Recognition Using Convolutional Neural Network *Conference: ACM Multimedia At: Orlando, Florida November 2014* http://dx.doi.org/10.13140/2.1.3082.1120

Marangon, F. Tempesta, T. Troiano, S, Vecchiato D. (2014) Food waste, consumer attitudes and behaviour. A study in the North-Eastern part of Italy 201 *Rivista di Economia Agraria Anno LXIX, n. 2-3 – 2014* Università degli Studi di Firenze – Firenze University Press http://dx.doi.org/10.13128/REA-16922

Gustavsson, J. Cederberg, C. Sonesson, U. (2011) Global Food Losses and Food Waste Save Food Congress, Düsseldorf 16 May 2011 https://www.madr.ro/docs/ind-alimentara/risipa_alimentara/presentation_food_waste.pdf

References

Schanes, K. Dobernig K. Gözet, B. Food waste matters - A systematic review of household food waste practices and their policy implications *February 2018 Journal of Cleaner Production 182* http://dx.doi.org/10.1016/j.jclepro.2018.02.030

Aschemann-Witzel, J. de Hooge, I. Amani, P. Bech-Larsen, T. Oostindjer, M. (2015) Consumer-Related Food Waste: Causes and Potential for Action *Sustainability 2015, 7(6), 6457-6477* https://doi.org/10.3390/su7066457

Edward, E. Heer, J. Narrative Visualization: Telling Stories with Data (2010) *IEEE Transactions on Visualization and Computer Graphics (Volume: 16 , Issue: 6 , Nov.-Dec. 2010)* http://hci.ucsd.edu/220/NarrativeVisualization.pdf

Weber, W. Engebretsen, M. Kennedy, H. Data stories. Rethinking journalistic storytelling in the context of data journalism (2018) *Studies in Communication Sciences 18.1 (2018), pp. 191–206* https://digitalcollection.zhaw.ch/bitstream/11475/2531/2/2018_Weber_Data_stories.pdf

Matei, S. A. Hunter, L. (2021) Data storytelling is not storytelling with data: A framework for storytelling in science communication and data journalism, T*he Information Society*, https://doi.org/10.1080/01972243.2021.1951415

References

Rejmaniak, R. (2021) Bias in Artificial Intelligence Systems *Bialystok Legal Studies Białostockie Studia Prawnicze 2021 vol. 26 nr 3* http://dx.doi.org/10.15290/bsp.2021.26.03.02

Feldman, S. S. Yalcin, O. N. DiPaola, S. (2017) Engagement with Artificial Intelligence through Natural Interaction Models *Electronic Visualisation and the Arts (EVA 2017) (EVA)* http://dx.doi.org/10.14236/ewic/EVA2017.60

Vimal, B. Linsey, J. Anderson, D. Richard, D. Otto, K. Wood, K. (2017) Design prototyping methods: state of the art in strategies, techniques, and guidelines *Cambridge University Press: 03 August 2017* https://www.cambridge.org/core/services/aop-cambridge-core/content/view/560B306A5E799AEE54D30E0D2C1B7063/S2053470117000105a.pdf/design-prototyping-methods-state-of-the-art-in-strategies-techniques-and-guidelines.pdf