OULU UNIVERSITY OF
APPLIED SCIENCES

Truc Le

FOOD WASTE IN SUPERMARKETS

FOOD WASTE IN SUPERMARKETS

Truc Le
Bachelor’s Thesis
Autumn 2020
Information Technology
Oulu University of Applied Sciences

ABSTRACT

Oulu University of Applied Sciences
Degree Programme in Information Technology

Author: Truc Le
Title of the bachelor's thesis: Food Waste in Supermarkets
Supervisor: Pekka Alaluukas
Term and year of completion: Autumn 2020 Number of pages: 68 + 7

This thesis was introduced as the development of the Food Robin Hood application which was a part of the Supermarket Python Project aiming for a unique food waste solution for supermarkets in Finland. Hence, the aim of the thesis was not only to contribute a new solution to reduce the eatable food waste in Finnish retailing by reusing but also to apply web technologies to solve the critical and realistic problem.

Besides the solid foundation by the research and analysis of food waste in the overview, the thesis initiated and developed a responsive web application with the use of modern web technologies, such as programming with TypeScript, the front-end work with the React library and the Redux toolkit, the back-end work with Node.js, ExpressJS, and MongoDB, and the deployment via the Google Cloud Platform. To ensure the workflow as well as the time frame, this thesis was applied Trello as the project management tool for better results. Derived from the Supermarket Python Project with fundamental ideas, orientation, and objectives, but deeply focused on the technical side, the initial application was built and developed with full features as requirements.

Consequently, the Food Robin Hood was published successfully on a public site with the domain provided by a third-party company with Github. With many efforts in completing the research part as the panorama of food waste in Finland as well as implementing and developing a web application in the real-life project, the goals of this thesis were achieved despite a few difficulties and challenges during the process. Last but not least, this thesis as well as the Supermarket Python Project would be the premise and positive effect for further development in the future for minimizing the socio-economic loss from food waste and aiming for a sustainable society.

Keywords: Food Waste, TypeScript, React, Redux, Node.js, ExpressJS, MongoDB

PREFACE

Firstly, as the preamble to my thesis, I would like to send a big thank you to my teammates, the Supermarket Python Team for giving me permissions to use the brainchild of our team, the Supermarket Python Project for my thesis. Thus, a thank you and an apology to my supervisor Pekka Alaluukas for his patience and supports in my thesis despite my delays in a very tough time. Also, I am grateful to my Head of Degree Programme Susanna Kujanpää for her great support and follow-up along my study, especially my thesis. And I would like to show my appreciation to my teacher Kaija Posio for spending her valuable time checking and guiding me through my thesis.

Then, I would like to appreciate my sweet friends supporting my thesis from the research to the development stages. A thank you from the bottom of my heart to you guys, Mats, Daniel, and Diane for your great support to me. Moreover, I would like to express my sincere gratitude to Sari Kokko, Store Manager of K-Supermarket Joutsensilta. She was the one who inspired the Supermarket Python Team for the initial project idea and made many efforts to support our team. And I thank Sari also for letting me show this in my thesis with her supermarket name here.

And, the very special thanks go to the most important person who has accompanied me during this thesis and helped me in reaching all goals, as well as the best result of my thesis. I would like to embrace my beloved and very best friend for the great things he did, especially his advice, experience, and knowledge on the technical side that was so useful for my thesis work. Once again, I thank my companion for helping, encouraging, and standing me from the beginning until the last moment.

Last but not least, I would like to thank all my dear friends for cheering me up when I was severely stressed and depressed about the thesis. Your encouragements were the power to motivate me to complete this. And, for my last words, I would like to thank my family for the unconditional love, great support, and lifting my spirits always for the achievements I have got so far today. Thank you very much.

Oulu, 20.12.2020

Truc Le

CONTENTS

VOCABULARY

API	Application Programming Interface
B2B	Business to Business
B2C	Business to Consumer
DevLAB	One of OAMK LABs which are training programs for students in all fields to improve skills and competences by developing real-life and applied projects
DOM	Document Object Model
ES6	ECMAScript 2015
EU	European Union
GUI	Graphical User Interface
HTTP	Hypertext Transfer Protocol
IDE	Integrated Development Environment
I/O	The communication process (including getting data in and returning data out) between an information system and the outside environment
JSON	JavaScript Object Notation
JSX	JavaScript Syntax Extension
LUKE	Natural Resources Institute Finland
MVC	Model – View – Controller
NGO	Non-Governmental Organization
NPM	Node Package Manager

OOP	Object-Oriented Programming
Project FUSIONS	Food Use for Social Innovation by Optimizing Waste Prevention Strategies is a project aiming for effective usage of the resources in Europe by food waste reduction
RAM	Random Access Memory
RDBMS	Relational Database Management System
SDG	Sustainable Development Goal
SDLC	Software Development Life Cycle
SPA	Single-Page Application
UI	User Interface
UN	United Nations
URL	Uniform Resource Locator
US	United States
UX	User Experience
WFD	Waste Framework Directive

1 INTRODUCTION

Aiming for a better world and a green and clean planet in the future, in 2015, the UN has made a call for actions with 17 Sustainable Development Goals in all fields including the improvement of the quality of life, education, health and well-being, inequality, climate and environment, and social development. Regarding the 12th SDG about the responsibility for consumption and production, one-third of food production with an estimation of 1.3 billion tons, which costs around 1 trillion US dollars, is wasted, and lost globally per year leading to negative impacts on the natural resources, environment, economics, and the development of the society consequently. (1)

Particularly, the amount of food waste in Finland yearly including edible food is about 400 to 500 million kilos, which accounts for 15% of food loss according to LUKE (2). Also, LUKE has estimated the impact of food waste from the food chain on the climate is equal to the emission of 400,000 cars annually (2). Therefore, reducing food waste and loss in all sectors from the production, supply, and consumption in half by 2030 is one of the immediate targets of the 12th SDG wherein Finland and other European countries have aimed to accomplish (3).

To contribute a new solution to the food waste problem in Finland, especially for Supermarkets, this thesis originates from the Supermarket Python Project aiming at B2B customers instead of current food waste solutions mostly focused on the B2C model. The Supermarket Python Project is a project researched and developed from the food waste subject in DevLAB in the Oulu University of Applied Sciences in Autumn 2019 by the Supermarket Python Team with 6 students. The objective of this project was oriented towards the zero-waste in Supermarkets, to create sustainable values for the community, and to increase awareness about food waste.

As previously mentioned, targeting the B2B customer group, the potential customers include Supermarkets, Non-profit Organizations, Restaurants and Coffee Shops, and Farmers. By playing a role as a mediator, Supermarket Python collects food waste from Supermarkets and shares the food to where it could be reused, such as Non-profit Organizations, Restaurants and Coffee Shops, and Farmers. The food donated from Supermarkets is completely free of charge.

Therefore, this thesis introduced as the Food Robin Hood Application is initiated from the basis of the Supermarket Python Project via the initial stage: The platform where all the aforementioned customers can join to support each other in reducing food waste. In this application, users can post their requests for receiving or donating food as well as follow the news about food waste contributions to the community or the efficiency of food waste activities in the community in Finland.

The Food Robin Hood Application is a web application using modern web technologies including a programming language via TypeScript, front-end development with React and Redux, back-end development with Node.js, Express, and MongoDB, and deployment via the Google Cloud Platform. The objective of this thesis is not only to complete the research part of the Supermarket Python Project but also to apply new technologies to support a real-life project. With the scope of the project and its huge benefits, the Supermarket Python Project through the Food Robin Hood demo application will promise a high valuation for a zero-waste in Supermarkets and sustainable development in the future.

2 THE OVERVIEW OF FOOD WASTE IN RECENT YEARS

2.1 Food Waste Issue in Overview and Its Impacts

Food waste is also defined as the resourcing prodigality including land, water, energy, workforce, manufacturing, and transportation (4). Due to the growth of the world population yearly, reducing food waste by changing the diet and ensuring the production and consumption progress effectively is essential for the food supply for the future of up to 9 billion inhabitants in the world (5).

Regarding statistics from the project FUSIONS, the amount of food waste in the EU has reached 88 million tons per year, which accounts for 20% of the food amount supplied to consumers. The urbanization, which is also considered to have a very close relation to food waste, is happening not only in wealthier countries but in low-income countries as well. However, the circumstances in the less developed countries are more critical because of the demand for managing the waste process. (5)

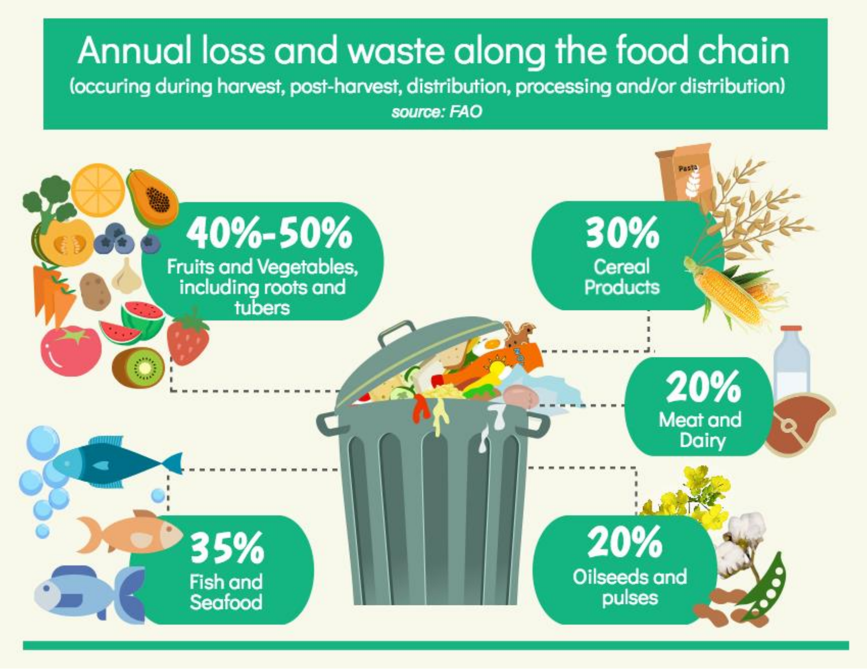


FIGURE 1. The global food loss and waste annually in the food chain dividing by various food groups (6)

In developed countries such as the EU and Finland, the food waste issue occurs mainly in the consumption stage whereas, in developing countries, food waste is caused in production mostly because of the lack of high technology (5). Moreover, imagining the global food waste amount as a country, the greenhouse gas emission of this country would be ranked third following after the US and China (4). Figure 1 shows the global food loss and waste dividing into different groups of food in percentage per year.

Besides, the impacts of food waste are multidimensional not only on the environment but also on economics, society, and human well-being. Direct impacts from food waste may cause notable consequences in agriculture, water consumption, and transportation, for instance, the demands for more land to crop, more freshwater supplies to produce food, and more fossil fuel to transport food (4).

Approximately 1.4 billion people are living in a water shortage condition while food waste also means water waste. As the examples, regarding Move for Hunger, wasting a glass of milk means wasting 1,000 litters of water in producing that wasted milk, or wasting one kilo of beef means 50,000 litters of water poured out. (4)

In another aspect, landfills are the major reason for pollution from solid waste due to unattended methods (4). The methane, one of the toxic elements of the greenhouse gas, is created when the food waste stops in landfills (4). As a consequence, environmental phenomena including global warming and climate change have occurred in recent years (4). 3.3 billion tons of greenhouse gas emissions each year amounted to the carbon footprint from the inedible food regarding a UN report in 2013 (5).

On the other hand, the impacts of food waste are affected by different cultures somehow. The influence of the culture on dietary habits happens as a natural characteristic from distinct regions in the world and leads to the differences in the quantity of food production in the food industry. According to a study by the UN in 2013, the highest continents that emitted greenhouse gas emissions were Asia, Europe, and North America respectively. Specifically, Asia produced emissions chiefly from rice production whereas the emissions in Europe and North America were from the highly consumptive proportion of cereals and meat products, and the greenhouse effect as well. (5)

Regarding the project FUSIONS, the estimated value of the eatable food, which is thrown away every year in the EU-28 from the food supply chain, was 143 billion euros. Food waste also relates to malnutrition and starvation. There are 815 million people in the world in hunger each year while the amount of food waste could feed those people against starving instead of ending up in the trash bins. In Finland, over one-third of the impacts on the environment are caused by food consumption. (5)

As a response to the target 12.3 of the SDGs of the UN, The Finnish Government has drafted the National Waste Plan as well as the Waste Act Reform against food waste in all sectors in the food supply chain. According to a report on food policy, the Finnish Government stated that the best solution to reduce food waste, in general, is through education and the increase in awareness of food waste. (5)

2.2 Food Waste in All Sectors in Finland and The Causes of Food Waste

According to a report, five sectors which contributed to food waste in Finland consist of households, catering and dining services, retailing, food manufacturing, and primary production (5). Figure 2 illustrates the share of food waste in Finland in all sectors in which the proportion of food waste contributed by households is the highest with 32% whereas the least percentage of food waste belongs to the primary production with 13% (5). However, due to a lack of statistics on the primary production sector, this report analyzes the situations happening in households, catering and dining services, retailing, and food manufacturing.

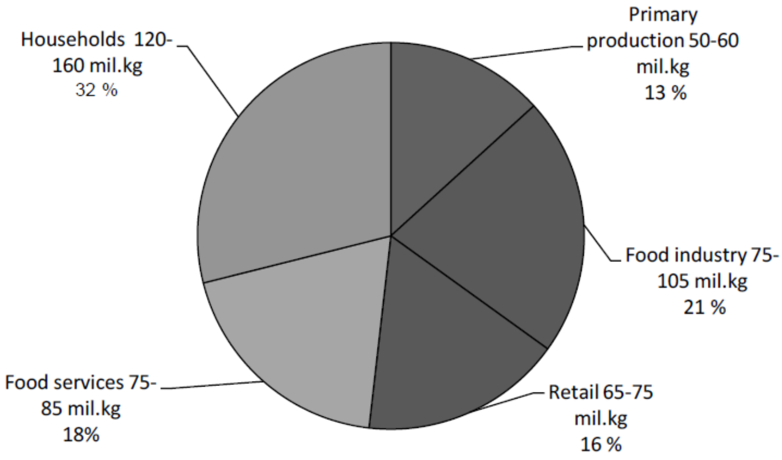


FIGURE 2. The share of food waste in all sectors in Finland (5)

2.2.1 Food Waste in Households

According to a research, each Finnish household spent roughly 210 euros yearly on eatable food waste, which was estimated at around 100 euros per capita. Then, that led to the spending on food waste of Finnish households in general approximately 4,200 euros in total. The annual consumption of 500 to 600 kilos of food in Finnish households with around 23 kilos per person accounted for 4% to 5% of the purchased food. (5)

Particularly, the quantity of food waste in households has correlated closely to how big households are. For example, households with a single person generated less food waste than other kinds of households, such as households with 2 adults or with children (5). Figure 3 shows the amount of food waste happening in distinct types of households in Finland.

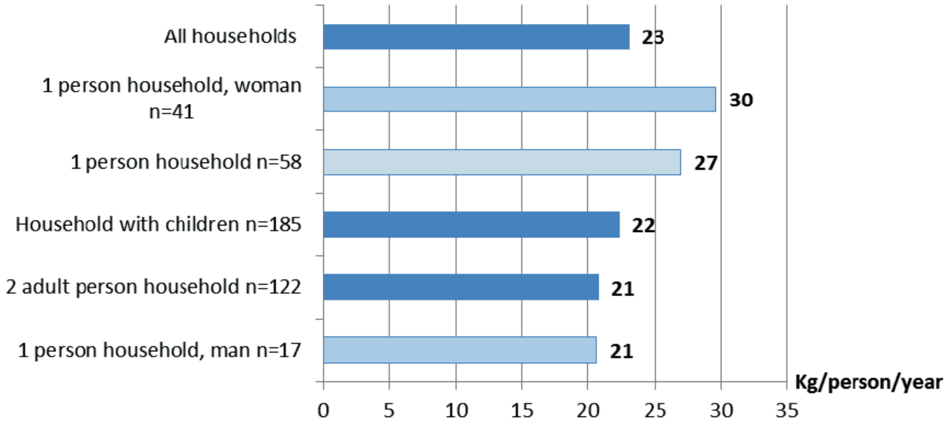


FIGURE 3. Food waste amount in different kinds of households in Finland (5)

Moreover, the types of food wasted in households were calculated specifically in figure 4. For instance, the highest rate belonged to the perishables (comprising vegetables and potatoes, fruits, and bread at 19%, 13%, and 13% respectively). They were followed by well-prepared food (18%) and dairy products (roughly 15%). Other kinds of food, such as fish, egg, meat, rice, pasta, and convenience food were at a lower rate with under 10%. (5)

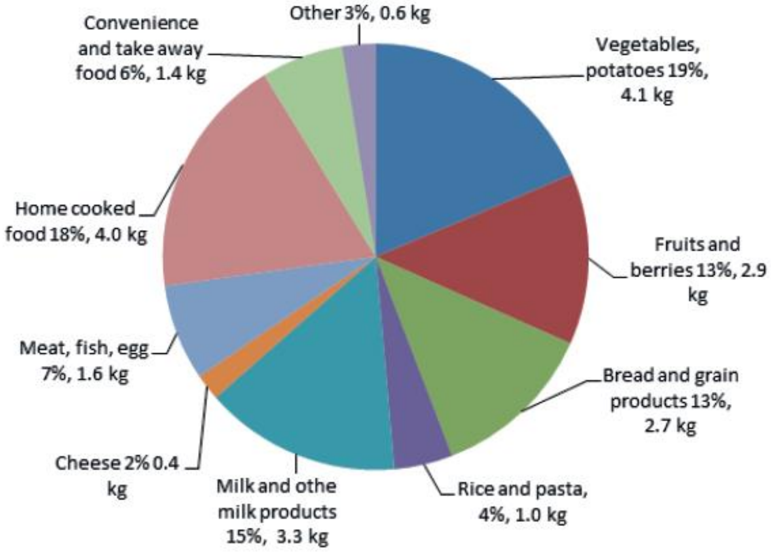


FIGURE 4. The types of food wasted in Finnish households in percentage (5)

Besides that, the share of the plant-based and animal-based food waste was recorded at 32% and 24% respectively. The number of estimated energy lost from food waste was 25,000 kcal per person yearly, which meant 70 kcal per person lost per day. (5)

Food waste in households was also caused respectively by spoiled food, past the expiration or best-before date, the plate-left waste, over-prepared food, and undesirable food. Depending on the types of food, the causes varied in the amount. For example, for the cause of spoilage, most items were vegetables, potatoes, fruits, pastries, and grain products. (5)

But, for prepared food, the main causes of food waste were due to the leftover on plates or food cooked excessively. And the major cause of food waste in most categories, especially milk and dairy products was passing the expiration date. (5)

Notwithstanding, except for the cause of food waste by spoiling, the most common reason has caused food waste from the misunderstanding of two kinds of expiration dates including the “best before” and the “use by” (6). The “best before” means that the food is less tasty rather than unsafe food while the “use by” means the food should not be used later due to hygienic reasons (7).

According to the European Commission, food marked “best before” label includes the group of frozen, refrigerated, dried, and canned food whereas the “use by” label is applied to all kinds of fresh food, for instance, meat, fish, vegetables, or fruits (7). Furthermore, a report of LUKE said that food waste in households also came from the inadequacy of planning with purchased food, or lack of time to cook or use food, or even the leftover that had never been eaten (8).

Additionally, discounts on food products and the food wasted level in households did not correlate with each other. The study Koivupuro showed that households buying discounted food also have a similar food waste amount when compared to others. Yet, households preferring cheap price products tended to waste less than normal households. (9)

2.2.2 Food Waste in Catering and Dining Services

In the catering and dining service sector, the foodservice produced 75 to 85 million kilos of food waste annually, which contributed 18% of the total amount in the whole of Finland. Figure 5 indicates food waste situations happening in different kinds of restaurants with three main causes. Three major reasons leading to food waste in this sector include kitchen waste, serving waste, and plate waste. (5)

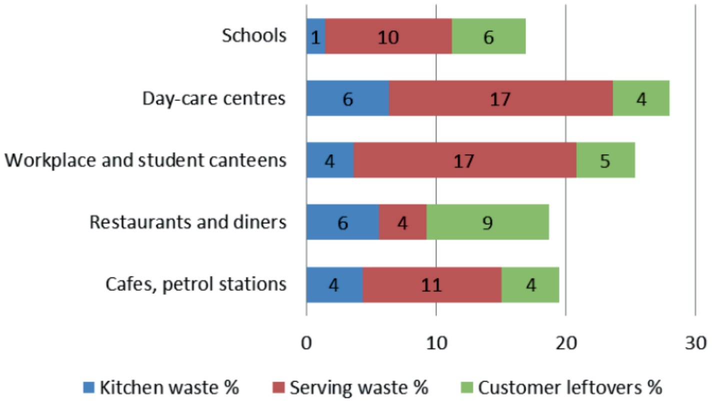


FIGURE 5. The causes leading to food waste in distinct types of restaurants (5)

The leftovers on customers' plates were the main cause of food waste in à la carte restaurants and diners with 9.5% whereas in the cafeterias including the cafeterias at workplaces or schools, the cafes, and petrol stations, the highest food waste amount came from the serving waste, especially, from buffet serving at from 17% to 28%. Kitchen waste which was caused by food storing and processing was the lowest (in the insignificant range of 1.5% and 6.4%) in comparison with others. (5)

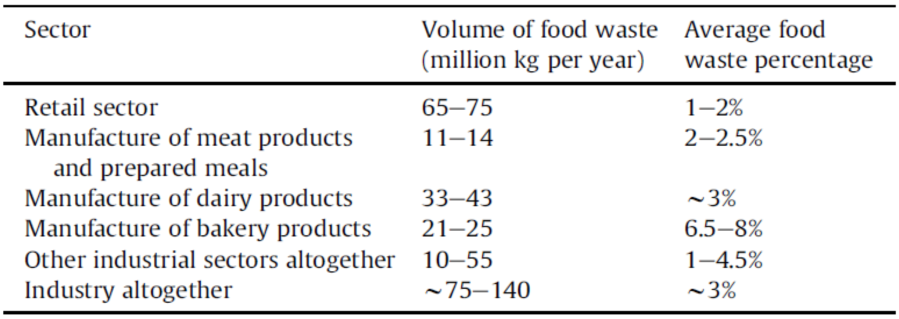
Particularly, serving waste in the cafeterias and student canteens were the highest, and the proportions in the cafes, petrol stations, and nursery schools followed next with roughly 10%. For the causes of the customer leftovers, side dishes were wasted much more than others, for instance, potatoes, rice, and pasta with 29%, or vegetables, salad, and fruits with 25%. Nevertheless, the entrées with meat or fish were less wasted than side dishes. (5)

2.2.3 Food Waste in Retailing and Food Manufacturing

The generation of 65 to 75 million kilos of edible food waste yearly belonged to Finnish retailers with 16% in total. The most wasted food groups belonged to bakery products and the perishables, such as various types of bread and pastries, vegetables, and fruits while fresh food (for example, meat and fish), dairy products, and convenient food were considered the second group of wasting. (5)

While those fresh products were discarded mostly because of customer's expectations of food freshness or attractiveness (10), the least wasted food groups were the frozen, dried, and tinned products, as well as the non-perishable food (5). Table 1 illustrates the proportion of food groups wasted in the Finnish retailing sector generally.

TABLE 1. The amount of food waste sorted into different food groups in Finnish retailers and food manufacturers (9)



Sector	Volume of food waste (million kg per year)	Average food waste percentage
Retail sector	65–75	1–2%
Manufacture of meat products and prepared meals	11–14	2–2.5%
Manufacture of dairy products	33–43	~3%
Manufacture of bakery products	21–25	6.5–8%
Other industrial sectors altogether	10–55	1–4.5%
Industry altogether	~75–140	~3%

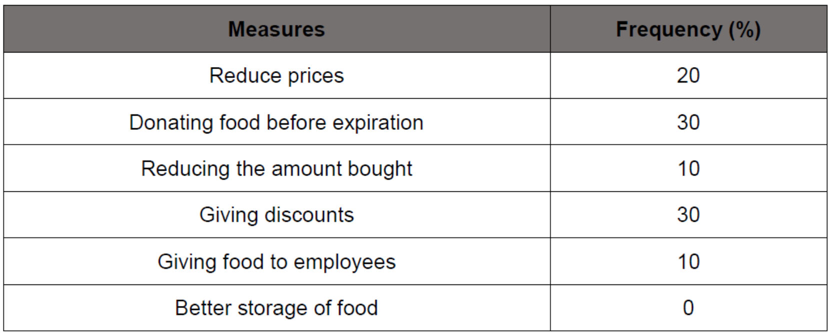
All the data about food waste in supermarkets is recorded and followed strictly via their systems and also by Finnish law. Under Finnish law, supermarkets are not allowed to sell food whose expired dates are over. Hence, the main reason causing food waste in this sector was the expiration term. (5)

Moreover, food waste in supermarkets happened mainly in-store and was dominated by consumer demands and behaviors. On the contrary, food waste caused by transportation or storing in warehouses was insignificant. (5)

According to the study, to solve the everyday food waste issue, supermarkets labeled the expiring food with discount tags to remove it from the stores. Additionally, the donation has been also one of the most effective solutions to eliminate expired food from the store. Measurements and the internal control of the wasting process including data collection, forecast, planning, or staff training were applied also to reduce and prevent food waste down to a smaller amount. (5)

Even though the edible discarded food every day in supermarkets was in a large amount, the result of current solutions shown in table 2 proved the inefficiency to eliminate food waste circumstance in the retailing field. The prevailing solutions being applied in supermarkets and measured with their frequency are illustrated via table 2. As a consequence, the disposal cost of food waste in a supermarket was estimated at around 150,000 euros per year when food waste has not been solved appropriately and stopped in landfills. (10)

TABLE 2. The efficient measurement of current solutions to food waste in supermarkets (10)



Measures	Frequency (%)
Reduce prices	20
Donating food before expiration	30
Reducing the amount bought	10
Giving discounts	30
Giving food to employees	10
Better storage of food	0

Meanwhile, accounting for 21% of the total food waste amount in Finland, the contribution of food waste of the food industry was 75 to 105 million kilos per year. Specifically, the proportions of food waste generated from the food manufacturing field were at around 6.5% to 8% for bakery production, 2% to 2.5% for butchery and meat production, as well as convenient food production, 3% for the dairy industry, and 1% to 4.5% for others. (5)

This calculation for eatable food waste did not include the peels of fruits and vegetables, husk, bran, or mill of grains and cereals as well as the rare or unused parts of animals taken from the butchery such as blood, viscera, or skin. Besides that, the primary production was not mentioned in the study, yet according to

LUKE, the food waste amount of this sector in Finland was calculated at around 50 to 60 million kilos annually with 13%. (5)

2.3 The Hierarchy of Food Waste and Current Solutions to Food Waste in Supermarkets in Finland

2.3.1 The Food Waste Hierarchy

According to LUKE, Finland as a member of the European Commission targets European society by recycling stages in product consumption by 2020. The objective of this is to not only reduce waste by encouraging the reuse of food waste instead of wasting but also to let this method become a business in Finland. (11)

That goal is drawn based on the hierarchy of waste released by the EU WFD for reusing and recycling materials and resources in aiming a zero-waste society and preventing negative impacts on human lives and the planet, such as environmental damage, socio-economic effects, and the loss of natural resources. (5)

The waste hierarchy is applied in all fields consuming resources to prevent it from wasting, especially edible food waste. Food waste hierarchy is the procedure for restricting food waste least, from the higher to the lower recommendation with 5 stages respectively including prevention, reuse, recycling, recovery, and disposal. (5)

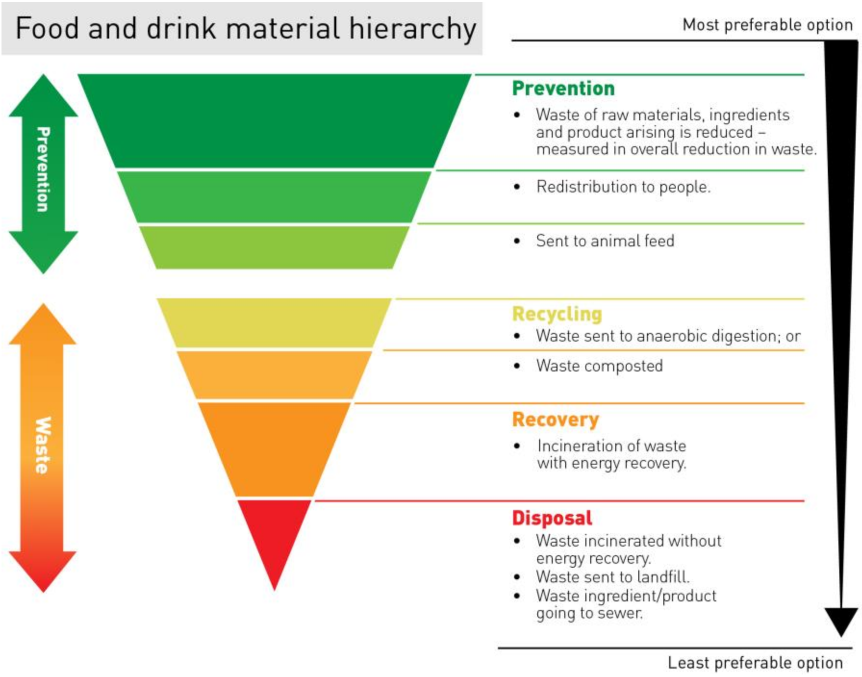

Food and drink material hierarchy
Most preferable option
Prevention
Waste of raw materials, ingredients and product arising is reduced – measured in overall reduction in waste.
Redistribution to people.
Sent to animal feed
Recycling
Waste sent to anaerobic digestion; or
Waste composted
Recovery
Incineration of waste with energy recovery.
Disposal
Waste incinerated without energy recovery.
Waste sent to landfill.
Waste ingredient/product going to sewer.
Least preferable option
Prevention
Waste

FIGURE 6. The hierarchy of food waste (12)

According to the food waste hierarchy, the most encouragement to reduce food waste is prevention from the smallest to biggest actions. Then, reuse is highly recommended if possible. Food is defined as waste unless it can be fed or used for people anymore. However, due to some special characteristics, the hierarchy of food waste needs to be applied strictly under the regulations, for example, the avoidance of food spoilage to ensure human health. (5)

2.3.2 Current solutions to Food Waste in Supermarkets in Finland

Froodly

Froodly is a Finnish startup company which helps supermarkets solve food waste issues by giving the information and prices of discounted food which is going to expire in supermarkets for consumers quickly via a mobile application named Froodly Go. Particularly, users will share the information, prices, and photos of the discount products expiring in stores into the application, then they will receive credit rewards for the information they share. Thus, other users can see the information shared and go to the supermarkets to buy the food. Froodly Go was officially launched in 2016, in Helsinki. (13)

From Waste To Taste

From Waste To Taste, registered as an NGO, operates a restaurant in Helsinki named Loop, which is the first food waste restaurant in Finland. The goal of From Waste To Taste is to reuse food waste instead of letting it be thrown away. This organization collects the everyday food waste in supermarkets and food manufacturers, then brings it to Loop to prepare new tasty dishes from food waste ingredients. (14)

However, this restaurant only uses around 10% of the collected food, so the rest will be donated to charities (13). Another social aim of this NGO is to support people in difficulties, such as the immigrants, the youth excluded from society, or the jobless from alienation and bring them back into life. This NGO has been in operation since 2016 (14).

WeFood

By opening a store named WeFood to sell food waste goods from supermarkets and food producers, Finn Church Aid has contributed a solution to reduce food waste situations happening in retailing and food manufacturing. All the goods sold in WeFood with the lower prices are excessive, but eatable products donated by supermarkets and food manufacturers, such as food with upcoming best before dates, flawed or unattractive fruits and vegetables, or food with few mistakes in packaging. (15) (16)

WeFood is the first food waste shop opening in Finland located in Helsinki since 2018 and aims to resell 50,000 kilos of edible food waste per year to consumers. This store is managed by Finn Church Aid and operated by volunteers. All profits will be used for Finn Church Aid’s charitable activities. (15) (16)

ResQ Club

ResQ Club is a Finnish company working as a solution to food waste problems. This company aims to eliminate food waste in supermarkets, restaurants, and cafes via the ResQ application. With the B2C model, ResQ helps supermarkets, restaurants, and cafes to discard excessive food by selling at a lower price to customers through the application while customers can choose and buy the desired food or meals at a cheaper price. This application has been launched since

2016 with more than 150 restaurants registered and has appeared in 4 countries in the EU. (13)

3 SUPERMARKET PYTHON PROJECT AS THE NEW SOLUTION

3.1 Project Background

The Supermarket Python Project was initiated and developed in DevLAB in the Oulu University of Applied Sciences in Autumn 2019 by an intercultural and disciplinary team with 6 members. Ideated from food waste topic, the Supermarket Python Team researched by meetings with some supermarkets, non-profit organizations, restaurants, and cafes in Oulu to understand deeply the current food waste situation and find out the best solution to tackle this issue effectively in Finland.

Thus, inspired by the food donation from a K-Supermarket to non-profit organizations, cafes, and farmers in tackling everyday food waste, the Supermarket Python Project was trying to create much more reuse cycles like that with small actions yet huge benefits for society and the environment. Besides that, this project was to not only solve food waste problems in supermarkets but also to create a sustainable and supportive community from the reuse of food waste.

3.2 Project Objectives

Based on the food waste hierarchy, Supermarket Python's objective was a sustainable society with less food waste and less hunger by reusing food waste in the 2nd stages. The most ideal solution was reusing it for people or animals instead of letting the eatable food waste in supermarkets end up meaninglessly in the landfills. Supermarket Python would cooperate with as many companies and organizations as possible in the effort of reducing food waste and aiming for the zero-waste ecosystem in Finland.

Specifically, Supermarket Python played a role as the mediator to collect food waste from supermarkets and share it to needed places, including non-profit organizations, restaurants and cafes, and farmers. Besides, Supermarket Python’s ambition was to not only create a sharing food waste community but to increase the awareness of food waste as well.

3.3 Project Idea and Development in Real Life

As previously mentioned, in Finland 4 companies are joining to support supermarkets to solve food waste issues including Froodly running with the C2C model, and From Waste To Taste, WeFood, and ResQ Club with the B2C model. Particularly, Froodly is an application for sharing information between consumers while From Waste To Taste and WeFood are trying to reduce food waste in supermarkets and food manufacturers' target consumers which are households chiefly.

Meanwhile, ResQ Club operates effectively by selling excessive food that is going to be wasted from supermarkets, restaurants, and cafes to consumers. However, the Supermarket Python Team found that to handle food waste issues in supermarkets and to consume the everyday food waste amount, required a management system to get more connections between companies and organizations. This meant that the more organizations and companies joined, the less food waste in supermarkets was.

Moreover, most restaurants and cafes used ResQ Club, yet most supermarkets preferred the donation to ResQ Club. Therefore, the potential customers that the Team aimed at were supermarkets, non-profit organizations, restaurants and cafes, and farmers for higher consumptions and the economical benefits for both parties. The main idea was that Supermarkets would donate food to Supermarket Python whereas Organizations including non-profits, restaurants and cafes, and farmers would receive the food from Supermarket Python and reuse it for their purposes.

For example, non-profit organizations could use food for events and gathering activities or charity. Restaurants and cafes could reuse the food and combine it with some new ingredients for preparing meals for their customers. Farmers could use food, such as bread or vegetables, for feeding animals.

Supermarket Python's service started with a platform named Food Robin Hood, where customers needed to register before use. Via this platform, all customers could follow news about food waste in the community as well as in Finland, see how efficient the activities contributed through the data system are, and especially make requests for donating or receiving food. Then, the food waste in supermarkets would be collected by Supermarket Python daily with supermarket's requests and brought to Supermarket Python's warehouse and stored in fully hygienic conditions for food safety. Next, the food would be distributed to Organizations as their requests with the Supermarket Python delivery service or self-pickup. (Figure 7)

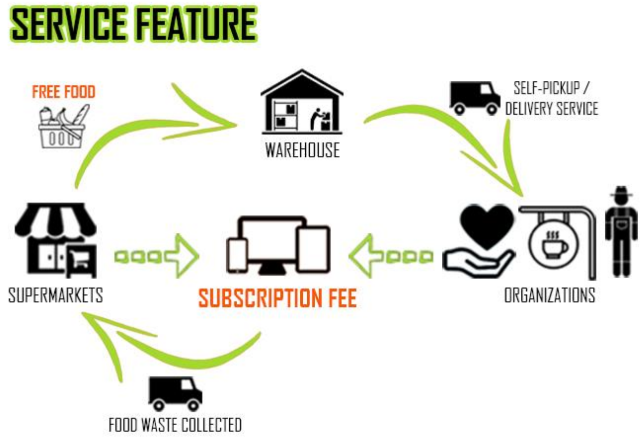


FIGURE 7. Supermarket Python's service feature

Supermarket Python's business was managing all the requests via the Food Robin Hood application, sorting food waste into groups of food, and storing the food hygienically in a cold storage. Additionally, Supermarket Python needed to plan the schedule to collect food waste from Supermarkets and distribute food to Organizations to ensure the food quality.

All the shared food was free of charge. Nonetheless, the subscription fee was required to maintain and develop the operation of Supermarket Python as the management agency between parties. Being a part of the community, Supermarkets and Organizations would make benefit together with Supermarket Python as the Win-Win-Win: Supermarkets would eliminate food waste in stores and save the disposal costs, Organizations would save money for food or ingredients, and Supermarket Python would create values for society as well as the business.

Furthermore, the target market that the Supermarket Python Team would reach was Finland with around 11,000 potential customers including supermarkets, non-profit organizations, non-governmental organizations, associations, restaurants, cafes, and farmers in the whole country. With the compromise for sustainability, Supermarket Python was unique in Finland with the B2B business model for higher contributions in dealing with food waste issues and better values for business customers. For instance, the platform Food Robin Hood would be the ideal place for all business customers to see each other and the efficiencies they contributed as a marketing activity. (Figure 8)

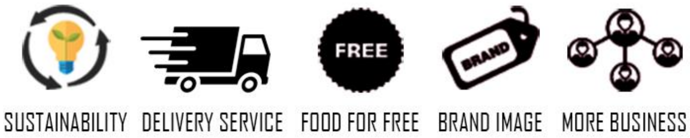


FIGURE 8. Customer values aimed in Supermarket Python Project

Even more, they also can get more connections as well as more business by being a member of a food waste community. Additionally, Supermarket Python planned to cooperate with biofuel companies about the waste treatment for the food waste left or unreusable. Hence, for the worst scenario when some food waste could not be reused, the next stages of the waste hierarchy as recycling and recovery would continue to lower the waste and limit impacts on the ecosystem.

Notwithstanding, due to the characteristic business model and the project, the practical research required much effort about the customer behaviors, the possibility of the project, business model, as well as the Finnish hygienic regulations leading to many challenges and time restrictions in DevLAB. Consequently, the Supermarket Python Project was still implementing with the final prototype on paper, not yet as a completed application. By that, this thesis continues implementing the initial stage of Supermarket Python’s service features: the Food Robin Hood application as a demo application.

4 THE FOOD ROBIN HOOD APPLICATION

4.1 Application Role and Contributions in Supermarket Python Project

As Supermarket Python's service feature, the primary step to run on the whole procedure was a platform named Food Robin Hood. From the practical perspective, Food Robin Hood would start the service cycle to handle food waste sharing procedures via the system in which the request creation was the most important. Supermarket Python can measure the everyday food waste amount in the retailers by donating requests and estimate how much food waste would be reused by supported requests.

Besides that, the Food Robin Hood could do precise measurements about food waste in the retailing via the data collected and also the amount of food waste reused efficiently instead of wasting. However, the Food Robin Hood, at first, aimed to support supermarkets in handling edible food waste by creating a community through a web application. Then, the next stages including collecting, sorting, storing, and delivering food waste could follow after to solve food waste issues thoroughly.

Moreover, Supermarket Python's objective was to create positive effects on reusing food waste as well as increase awareness of food waste in society by prevention and reuse. That required a media channel to spread the information, then to make the influences on society. Hence, Food Robin Hood also played a role as the major media channel for the Supermarket Python Project.

Last but not least, the Food Robin Hood application contributed to an advertising channel for customers to the Supermarket Python Project. By joining with Supermarket Python and appearing on the Partner list as a part of the food waste community, all business customers could increase their brand image with sustainability which is top trending nowadays. In the Food Robin Hood application, people could easily find food waste information and see efforts to reduce food waste in the Supermarket Python community contributed by supermarkets, non-profit organizations, restaurants, cafes, and farmers through the activity publications.

4.2 Application Descriptions and Requirements

The platform Food Robin Hood is a web application built in a responsive interface so that users can open it on any device, such as computers, tablets, and smartphones. The reason for the Food Robin Hood application developed as a web application instead of a mobile application is due to the characteristics of the target user: Supermarket Python was aimed at business customers, such as companies and organizations, who accessed mostly via computers at work more than portable devices.

However, designed with a responsive interface, users can open the Food Robin Hood on any browser and any device. With the target of around 11,000 users in the whole of Finland in the future as planning, Food Robin Hood is considered to be a large scale application with more user access and requests to execute. Therefore, it requires a steady and powerful, yet lightweight, flexible, and rapid fundamental.

Aiming at business customers means the Food Robin Hood must have a friendly, simple, and convenient UI, however, a highly secured system. Hence, to actualize those ideas, the requirements for the Food Robin Hood application include 6 features: Registration, News Feed, Food Request, Searching, Locating Partners via Map, and Payment. All features can be used for registered users. On the contrary, non-registered users only can know Supermarket Python and what is going in the community by activities, see partners participating in the project.

Firstly, as the non-users, the homepage without logging in is used to introduce the Supermarket Python Project with vision, mission, and objectives. Partner pages show the registered users as a part of the Supermarket Python community dividing into 4 distinct types of users shown as a list or via the map. The About Us page is where non-users can find more information about Supermarket Python whereas the News Feed page leads to the news about food waste activities and information which are pushed daily by admins from Supermarket Python.

Thus, to start all services as well as using the Food Robin Hood totally, it is necessary to register as a user by signing up at first. The Sign-Up page will show all the required information to register as a business customer divided into 4 types of users: Supermarket users, Non-profit organization users, Restaurant and Cafe users, and Farmer users. After signing up successfully, users can sign in to the Food Robin Hood and the Index page will appear as the News Feed page.

All the pages then are shown and used as the non-users also applied to users including searching other users, viewing Partners joining into the system, and reading newsfeed. Moreover, registered users can also see and edit their information via the Profile page. On the Profile page, users can easily find the View All Requests page and Create Request page where they can view or make their new requests for donating or being supported depending on the types of users.

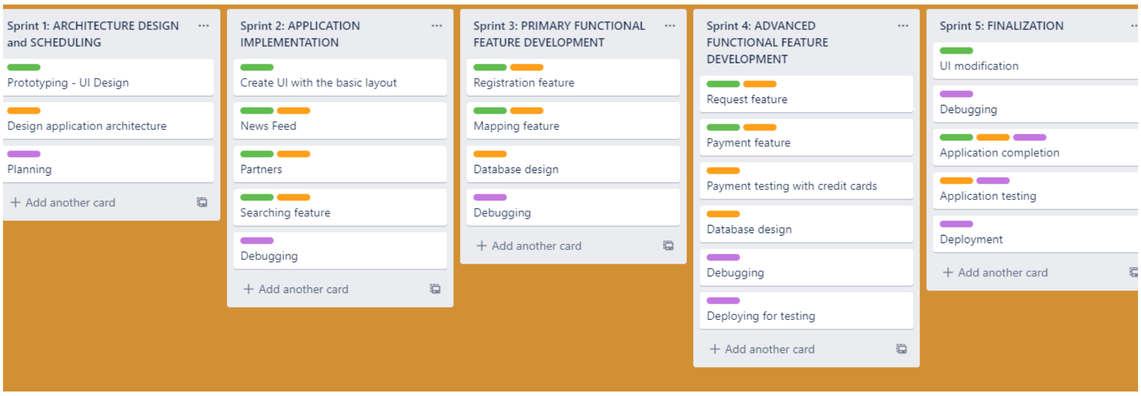
Particularly, Supermarket users can make donation requests whereas other users can make food supported requests. Thus, users can modify their pending requests by the edit button. Yet, the processed requests cannot be modified anymore. A request will change to a completed request once it is handled thoroughly by collecting or delivering by Supermarket Python.

Nevertheless, the Food Robin Hood application is provided to all registered users with the subscription fee mandatorily. This means that registered users need to pay before using the services. The payment can access via the Pricings page where they can choose a suitable bundle depending on their demands. Then, after the payment is completed, users can use full services on the Food Robin Hood.

5 PREPARATION FOR APPLICATION DEVELOPMENT

5.1 Planning

Starting the procedure of creating an application by planning will guarantee the work on the right way to execute. For the applicability and feasibility of the application development, the Food Robin Hood is divided into 5 sprints from a prime to an advanced level, including the architecture design and scheduling, application implementation, primary functional feature development, advanced functional feature development, and finalization. (Figure 9) Each sprint has been done sequentially to ensure that the workload is covered and completed before another one begins.



Sprint 1: ARCHITECTURE DESIGN and SCHEDULING
- 🟩 Prototyping - UI Design
- 🟧 Design application architecture
- 🟪 Planning

Sprint 2: APPLICATION IMPLEMENTATION
- 🟩 Create UI with the basic layout
- 🟩🟧 News Feed
- 🟩🟧 Partners
- 🟩🟧 Searching feature
- 🟪 Debugging

Sprint 3: PRIMARY FUNCTIONAL FEATURE DEVELOPMENT
- 🟩🟧 Registration feature
- 🟩🟧 Mapping feature
- 🟧 Database design
- 🟪 Debugging

Sprint 4: ADVANCED FUNCTIONAL FEATURE DEVELOPMENT
- 🟩🟧 Request feature
- 🟩🟧 Payment feature
- 🟧 Payment testing with credit cards
- 🟧 Database design
- 🟪 Debugging
- 🟪 Deploying for testing

Sprint 5: FINALIZATION
- 🟩 UI modification
- 🟪 Debugging
- 🟩🟧🟪 Application completion
- 🟧🟪 Application testing
- 🟪 Deployment

FIGURE 9. The development progress of the Food Robin Hood in scheduling

Besides that, in each sprint the tasks are assigned in 3 phases for the best result: the front end, the back end, and the process control. The time frame for a sprint lasts two weeks. The management project tool used for the Food Robin Hood is Trello.

5.2 Application Architecture

To ensure the requirements of the Food Robin Hood, such as scalability, a large number of users with up to 11,000, performance, UX, as well as develop the application in the best way, the application architecture should be designed most reasonably. The appropriate architecture might be beneficial not only for saving time and cost but also for increasing application efficiency significantly. Hence, the Food Robin Hood application applies the 3-tier architecture which aims for development rate, scalability, performance, and capability. (Figure 10)

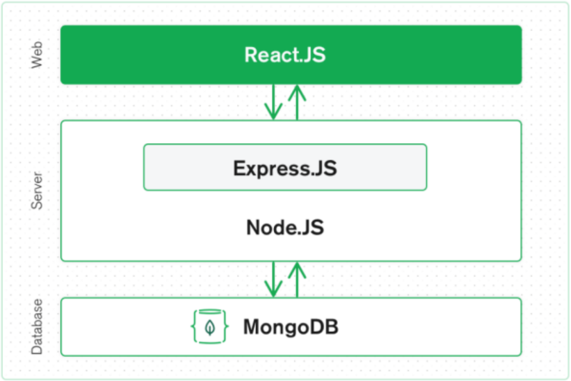


FIGURE 10. The 3-tier architecture (17)

The application consists of 3 main components or 3 tiers in another explanation: the client, APIs server, and database. Then all these 3 components are deployed on the Google Cloud Platform. The client and the APIs server run on Google App Engine services from a user-created project while the database is managed by MongoDB Atlas – a MongoDB cloud database system. (Figure 11)

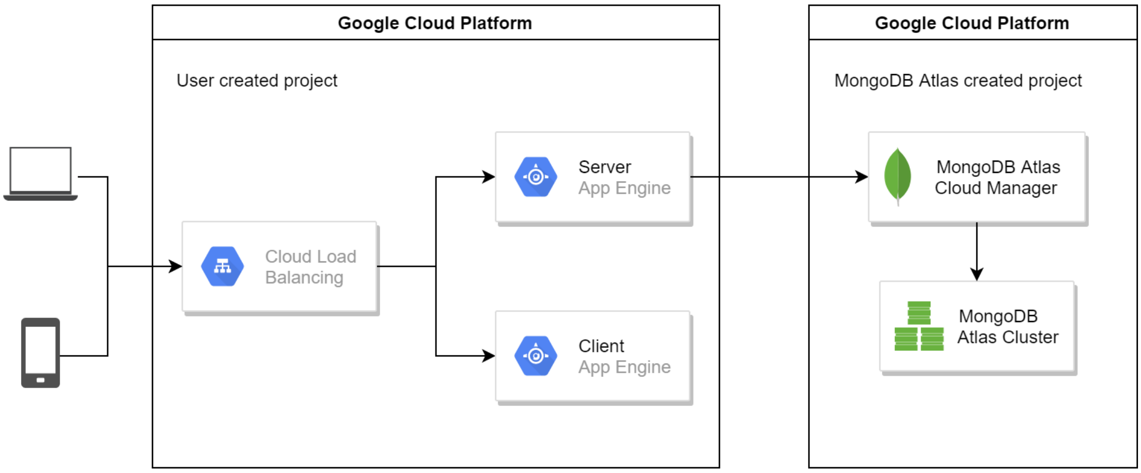


FIGURE 11. The high-level design of application architecture on Google Cloud Platform

The client is designed to work as an SPA, which is a web page with dynamic interactions directly towards the web browser by overwriting the prevailing page with the obtained data from the user input or server load. For that, React, a library that uses JavaScript to display data on a plain HTML, is chosen for front-end development. Moreover, the application state is managed by Redux to centralize the application data which React uses to display onto the web browser.

The client retrieves data from a RESTful APIs server, which is implemented with the ExpressJS web application framework and runs on a Node.js environment. ExpressJS is selected due to its minimalism and flexibility in APIs development that guarantees the requirements of the project whereas the server processes data from client requests and stores them on a MongoDB database. MongoDB is a non-relational database which stores data into documents and collections.

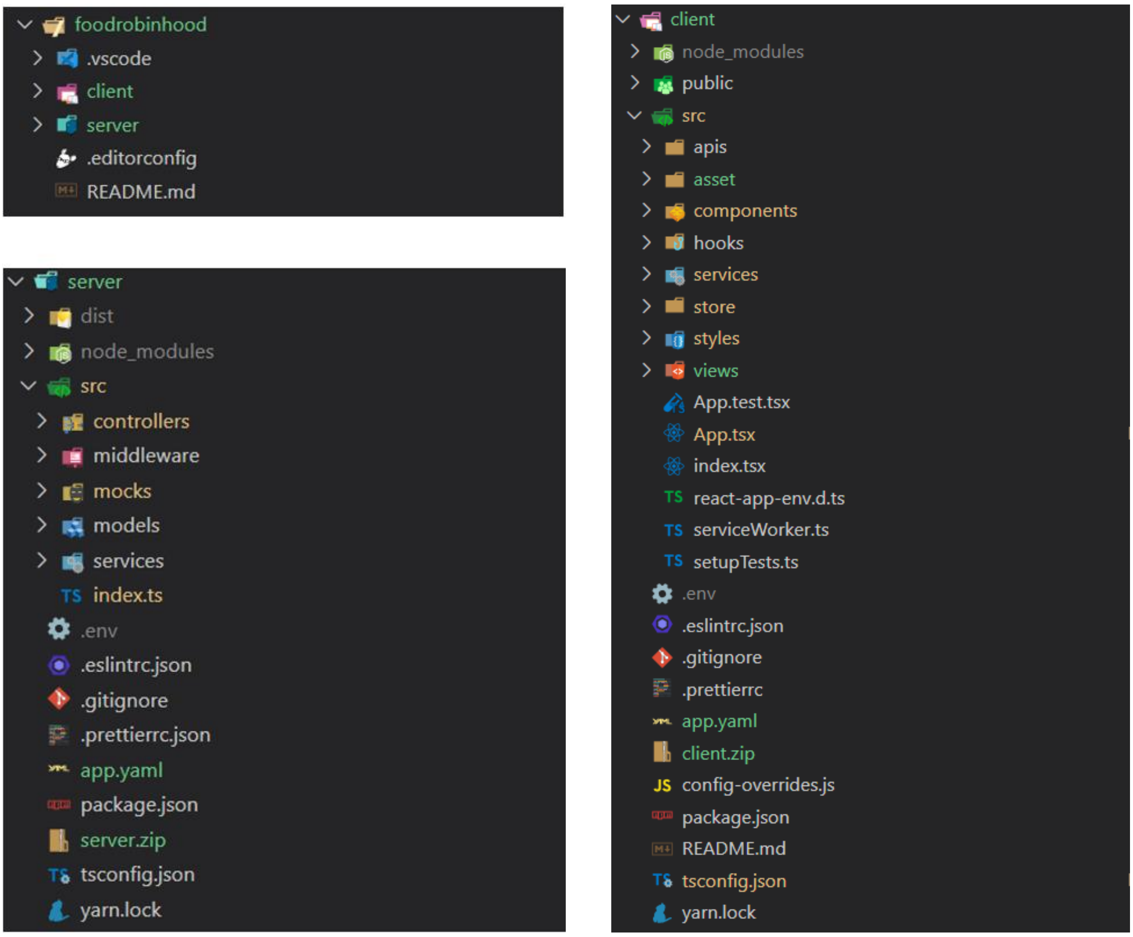
Using the architecture described above provides an extremely robust and easily modifiable system that helps in focusing on developing functionalities needed for the service without any doubt about the infrastructure. Additionally, the use of a single programming language for both client-side and server-side makes the development process and the debug much easier.

5.3 Software Requirements and Working Environment

The application needs to install some software before beginning the application development process. Node.js is installed for running the development environment. Besides, Yarn is used to manage packages and libraries for the Food Robin Hood application. Git along with Github is used as the version control system for the project. React devtool and Redux devtool are browser extensions that have to be installed for debugging during the development.

Visual Studio Code is used for managing the project workspace and writing code as an editor. Visual Studio Code is a lightweight, fast, open-source, and cross-platform. It also has numerous useful features and plugins to make it suitable for project development and debug, for example, plugins to check code spelling, format and organize code better, and avoid common mistakes.

The project workspace comprises the client and APIs server applications which are developed separately in different directories. Each application includes the configuration files in the root directory and source files in the “src” folder. Figure 12 below shows the structure of the Food Robin Hood application clearly.



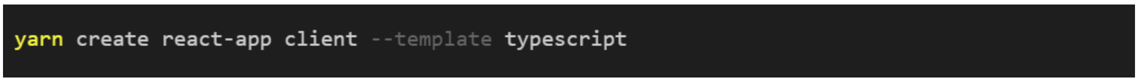
```
foodrobinhood
  .vscode
  client
  server
  .editorconfig
  README.md
```

```
server
  dist
  node_modules
  src
    controllers
    middleware
    mocks
    models
    services
    index.ts
  .env
  .eslintrc.json
  .gitignore
  .prettierrc.json
  app.yaml
  package.json
  server.zip
  tsconfig.json
  yarn.lock
```

```
client
  node_modules
  public
  src
    apis
    asset
    components
    hooks
    services
    store
    styles
    views
    App.test.tsx
    App.tsx
    index.tsx
    react-app-env.d.ts
    serviceWorker.ts
    setupTests.ts
  .env
  .eslintrc.json
  .gitignore
  .prettierrc
  app.yaml
  client.zip
  config-overrides.js
  package.json
  README.md
  tsconfig.json
  yarn.lock
```

FIGURE 12. Project and Application Structure

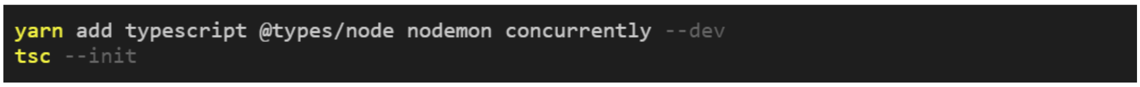
The front-end React application is created with the create-react-app library and it uses TypeScript as the programming language. Figure 13 presents the initialization by command line.



```
yarn create react-app client --template typescript
```

FIGURE 13. The initialization of React application by the create-react-app command line

For the APIs Node.js server, after initializing with the “yarn init” command in the “server” directory, the essential dependencies and dev dependencies are added together with a “tsconfig.json” file using the “tsc –init” command. (Figure 14)

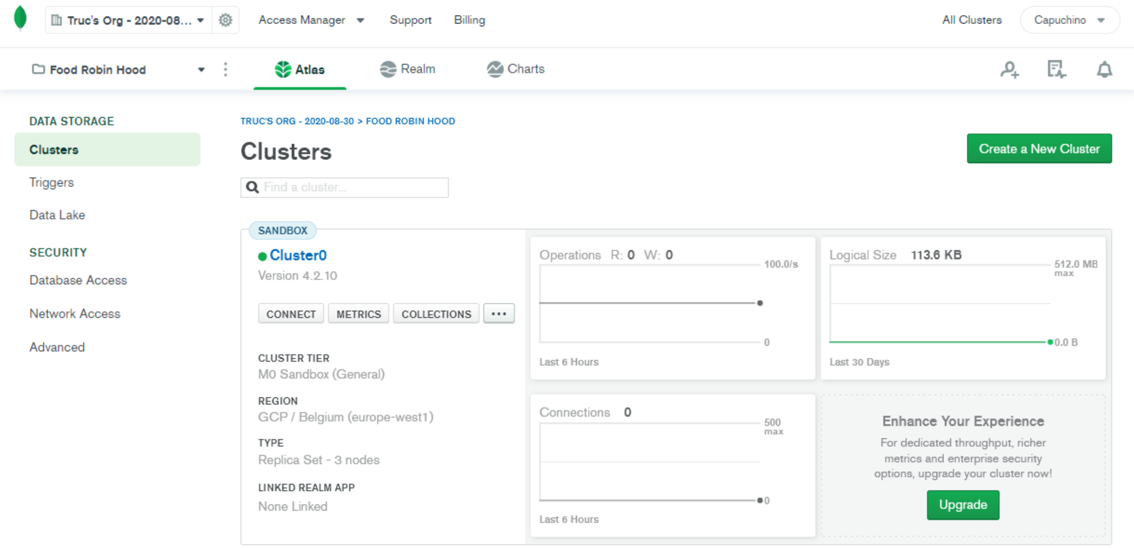


```
yarn add typescript @types/node nodemon concurrently --dev
tsc --init
```

FIGURE 14. Adding dev dependencies and tsconfig.json file for the server

About the database, the Food Robin Hood application uses the MongoDB database which is created and set up from the MongoDB Atlas dashboard as showing in figure 15. The database is then connected from the APIs server using an URL in the form:

mongodb+srv://<username>:<password>@<host>/<dbname>?retryWrites=true&w=majority



Cluster0
Version 4.2.10

CLUSTER TIER
M0 Sandbox (General)

REGION
GCP / Belgium (europe-west1)

TYPE
Replica Set - 3 nodes

LINKED REALM APP
None Linked

FIGURE 15. MongoDB Atlas dashboard

5.4 Designing

Aiming at business customers, the Food Robin Hood application should be designed with a convenient, simple, but optimal UI. As a part of the Supermarket Python Project, the UI design of the Food Robin Hood has been created from the initial paper prototype in that project, then improved with a new mock-up for the best effect on the UI and UX. Furthermore, the color scheme of the Food Robin Hood follows exactly its mother project in which it is inherited to preserve the sustainable visualization of the Supermarket Python Project. The prototype of the Food Robin Hood is displayed in appendix 1.

6 TECHNOLOGIES

6.1 TypeScript

TypeScript is a programming language developed from JavaScript programming, which is one of the most popular and core technologies in web development. TypeScript is convenient for developers when preferring to switch to JavaScript or vice versa via the compiler if necessary besides the thing that TypeScript commonly works with many frameworks, such as Angular, Ionic, or Node.js. Hence, TypeScript is somehow similar to JavaScript, yet they still have differences.

As the superset of JavaScript, TypeScript supports data-typing in both dynamic and static methods and structures the language around the OOP, such as Classes, Interfaces, Namespaces, or Inheritances. Annotations and strong typing are considered the advantages of TypeScript. This is suitable for large-scale applications when maintaining and expanding in the future rather than smaller ones leading to fixing bugs and issues via TypeScript is sooner and less complex.

In general, TypeScript supports developers in defining new types with modules, generics, and interfaces. Differing from JavaScript, Functions in TypeScript can use with optional parameters, and Numbers, Strings are considered as interfaces. Also, it is necessary to define the static type. Furthermore, the prototyping is supported in TypeScript which is not in JavaScript. (18)

Particularly, errors while coding is easier to be found at the compiling time with TypeScript instead of appearing at the running time as JavaScript. This is a huge benefit of TypeScript. Additionally, TypeScript shares the same libraries as JavaScript as well as the supporting community for help. (18)

Moreover, the new versions of ECMAScript are included in TypeScript. For example, the newest ES6 can provide a simple syntax to operate objects and declarations. However, unlike JavaScript, TypeScript works through the IDEs to write codes, test, and fix issues. Otherwise, a compiler is required to compile the code into JavaScript, such as the npm package. (18)

6.2 React

React is an open-source JavaScript GUI library focusing on performing the effective UI. It is classified mostly as the V in the MVC pattern. One of the most interesting things about React is its components with the customization and reusability of the elements in creating a UI. Additionally, the React component is easy to write by using the optional extension JavaScript as JSX to work with HTML and Javascript. (19)

By using Virtual DOMs instead of the normal DOM, React gives a better efficiency when the virtual DOMs are built and hosted in memory for a speedy response. Then with any changes, it will compare differences between the old and new one and load the updated parts into the page instead of reloading the whole page like DOM. (20)

The principle of React is through React elements added to ReactDOM, then, the React components including function and class types. Props and state are 2 important terminologies in React components in which props are invariant and used to fetch data from outside into components while state is the dynamic data working inside a component, following changes, and rendering for reactions. (20)

Besides, one of the most important parts while working with React is Hooks. Hooks are functions letting developers connect the React state and lifecycle into functional components. With Hooks, the state and lifecycle can be used without the ES6 class. (20)

Also, there are some available Hooks including the basics and advances, for instance, useState, useEffect, useContext, useCallback, useReducer, useRef (20). In overview, Hooks are beneficial to developers in simplifying codes, minimizing components, or replacing class-based components as functional components.

6.3 Redux

Redux, which is a JavaScript application tool to manage state, helps applications to work consistently in the client, server, or native environments. Redux is ideated from the combination of Elm programming language and Flux architecture (21). And it is used commonly with React for a better efficiency for the application.

React works mainly with components, yet, the larger the applications are, the harder the process of managing state between components becomes. Hence, Redux is created to deal with this problem by the 3 core principles: there is a single truth that existed, the state is read-only, and changes are made with pure functions. (22)

Specifically, about the operation, 3 principal elements in Redux workflow include Action, Store, and Reducers. Action are events to send data from the application to Store while Reducers are pure functions to keep the current state, make an Action, then return a new state while Store is to save the state and is the sole element in each Redux application. (22)

Furthermore, Redux Toolkit is created to fix issues that most developers get when working. For example, it has solved the complex store configuration, or the packages needed to be added. Redux Toolkit is ready to use with NPM, and Redux Toolkit is advantageous to developers with clearer and shorter code comparing to the previous structure. (23)

6.4 Node.js

Node.js is a platform which is built on the V8 JavaScript engine and written in JavaScript programming language. This platform has been developed since 2009. And via Node.js, applications can be built quickly and easily to expand to large-scale models. (24)

That is because its core is the creation of Node.js in C++ language and the V8 engine participating in converting JavaScript code into bytecode leading to a faster processing speed in realtime and a better performance. Moreover, the use of JavaScript in Node.js means that it is more simple to program applications with both the front end and the back end in a single language. (24)

About the mechanisms of Node.js, the non-blocking I/O is the most ideal when handling data beneath the system in comparison with the popular blocking I/O.

The Input and Output in the data manipulation require much time to execute data with many requests happening at the same time as the normal I/O. (24)

However, the nature of JavaScript is single-thread, yet multi-threads actions. Consequently, when the non-blocking I/O appears in Node.js, it solves that situation in the system and helps the server in executing more requests at one time. (24)

Additionally, the asynchronous mechanism of the Node.js APIs is necessary because the server never has to wait for an API for a response. Then, the server switches to the next API after that and starts the Event Loop in realtime. This process is called Event-Driven architecture, another advantage of Node.js. (24)

Besides that, NPM and Yarn are the two most popular tools created to manage JavaScript libraries in Node.js. Otherwise, the more open-source libraries are created and used these days, the more difficult the system management is. (24)

NPM is the most popular with highlighted features that are to access the online archive for packages or modules and to manage JavaScript modules and versions for projects. Meanwhile, Yarn is the successor of NPM with basically similar features and even more benefits about speed, reliability, and security. (24)

6.5 ExpressJS

ExpressJS is a flexible and minimalist back-end framework created for Node.js to develop web as well as mobile applications via the MVC. The HTTP methods and middlewares which are supported by ExpressJS can help in creating the API simply and sturdily. Moreover, ExpressJS plays an important role in handling HTTP requests and responses. (25)

Particularly, it implements the middlewares to get back HTTP requests, defines the router worked in different actions via HTTP and URL methods and lets the HTML receive responses with parameters of the Callback functions. Middlewares allows an action to be processed before any requests and modified before sending the response. (25)

Therefore, ExpressJS combining with Node.js is more powerful, convenient, and simple for works on the server-side. Figure 16 shows the interaction between ExpressJS, Node.js, and MongoDB for back-end solving. (25)

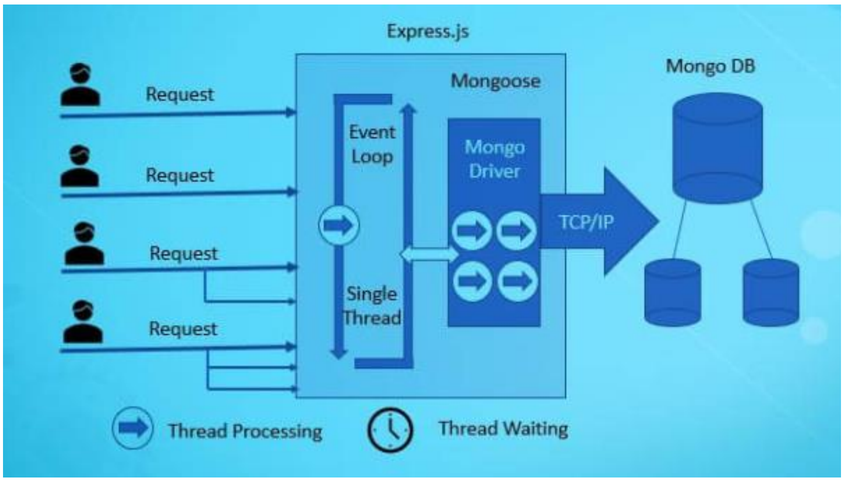


FIGURE 16. The ExpressJS, Node.js, and MongoDB in the interaction for back-end workload (25)

6.6 MongoDB

MongoDB is an open-source database management system as the NoSQL database. Hence, MongoDB avoids the table-based structure in the relational database to fit JSON documents with the flexible schema. MongoDB uses data stored in JSON, so each collection is various and in different sizes leading to its query speed is more rapid as a consequence. (26)

NoSQL, which is one of the advantages of MongoDB, appears as the patch for the existing disadvantages and shortcomings of the RDBMS for speed, features, and scalability. MongoDB uses the definition “collection” with flexible structures instead of “table” as usual. The above benefits in using MongoDB include the auto index (“_id”), the scalability in horizontal, the cache on RAM, the data aggregation, and higher performance. (26)

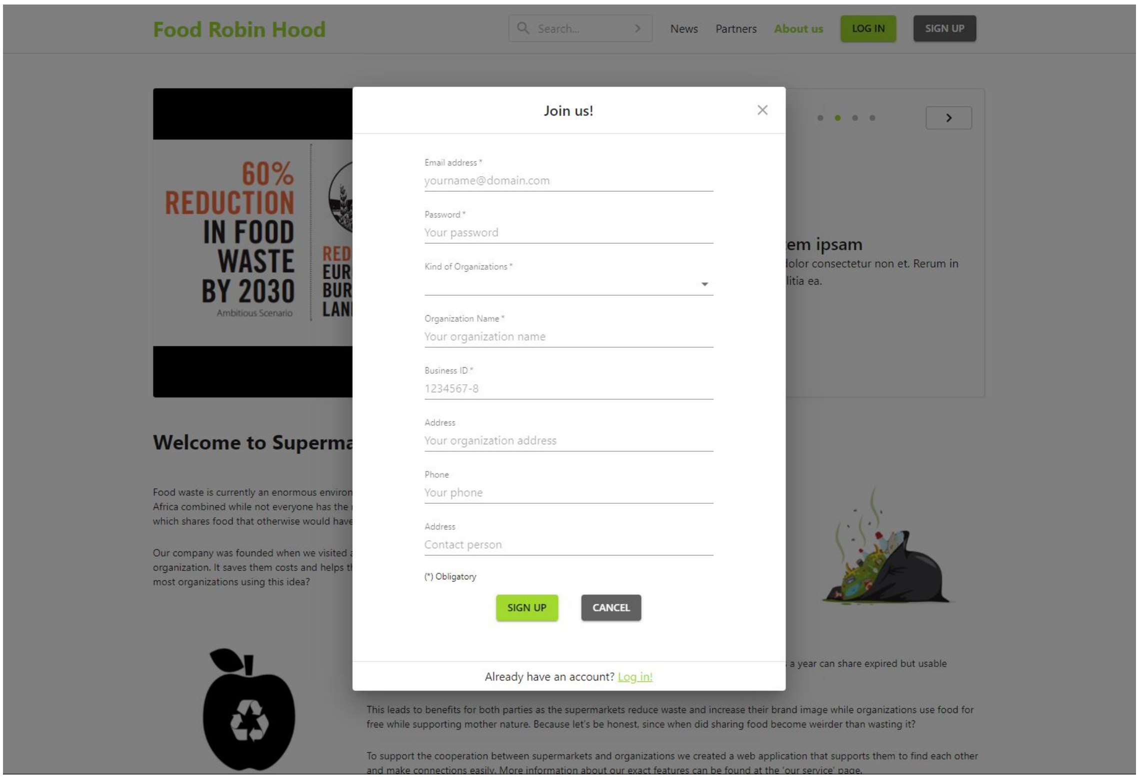
Besides, there are some disadvantages to MongoDB, such as requiring more memories in RAM, under 16MB size of documents. However, MongoDB is still suitable for systems that have a large number of requests, need a real-time response, and require fast queries with big data. (26)

7 IMPLEMENTATION

7.1 Features

7.1.1 User Registration

To start using the service, the user is required to register with an account. The registration dialog can be accessed by clicking the Sign-Up button from the navigation bar.



Join us!

Email address *
yourname@domain.com

Password *
Your password

Kind of Organizations *

Organization Name *
Your organization name

Business ID *
1234567-8

Address
Your organization address

Phone
Your phone

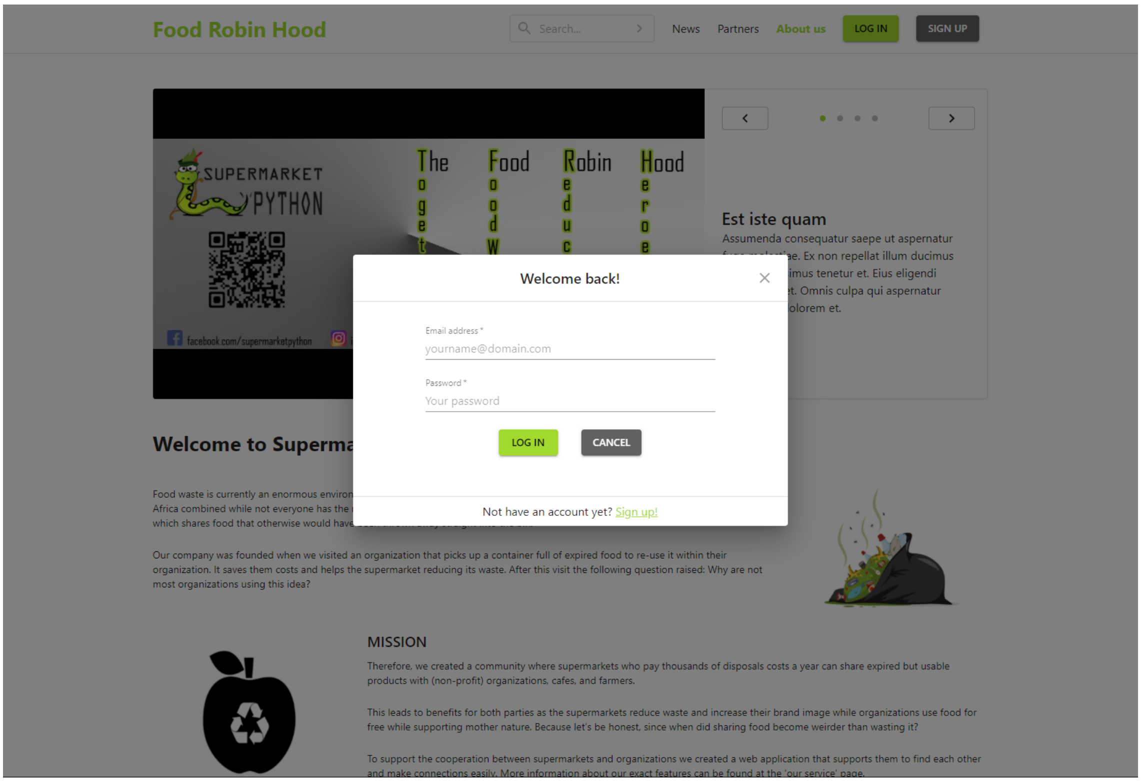
Address
Contact person

(*) Obligatory

Already have an account? Log in!

FIGURE 17. Registration dialog

Targeting business users, the registration form requires not only an email and a password as usual but also an organization name, a business ID, an address, and the type of organization. (Figure 17) After registering successfully, the user will be logged in to the application automatically. For later logins, the user can sign in from the log-in dialog via the Log In button on the navigation bar. (Figure 18)



Est iste quam

Assumenda consequatur saepe ut aspernatur fuga molestiae. Ex non repellat illum ducimus …imus tenetur et. Eius eligendi …t. Omnis culpa qui aspernatur …olorem et.

Email address *
yourname@domain.com

Password *
Your password

Not have an account yet? Sign up!

Welcome to Superma

Food waste is currently an enormous environ…
Africa combined while not everyone has the …
which shares food that otherwise would have …

Our company was founded when we visited an organization that picks up a container full of expired food to re-use it within their organization. It saves them costs and helps the supermarket reducing its waste. After this visit the following question raised: Why are not most organizations using this idea?

MISSION

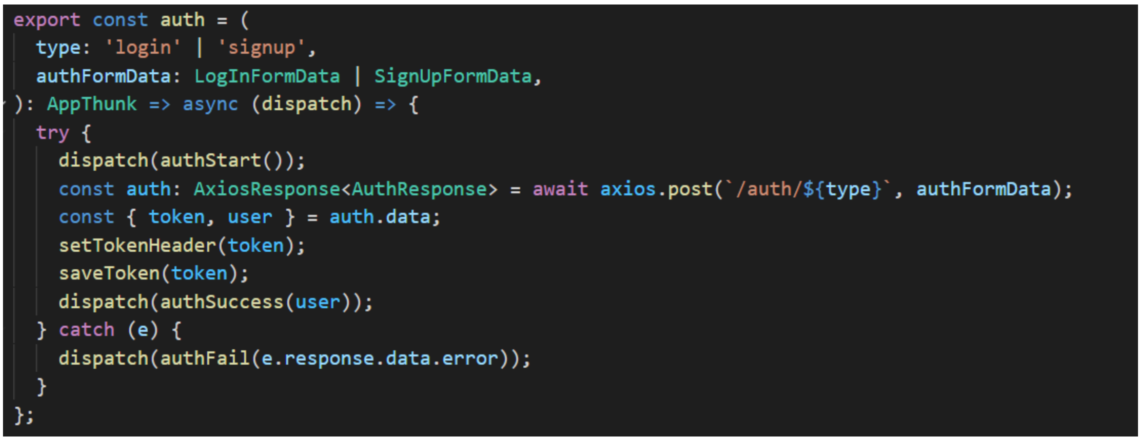
Therefore, we created a community where supermarkets who pay thousands of disposals costs a year can share expired but usable products with (non-profit) organizations, cafes, and farmers.

This leads to benefits for both parties as the supermarkets reduce waste and increase their brand image while organizations use food for free while supporting mother nature. Because let's be honest, since when did sharing food become weirder than wasting it?

To support the cooperation between supermarkets and organizations we created a web application that supports them to find each other and make connections easily. More information about our exact features can be found at the 'our service' page.

FIGURE 18. The login dialog

On the programming side, the authentication includes both the login and register that are handled from the client as a Redux action as shown in figure 19 below.

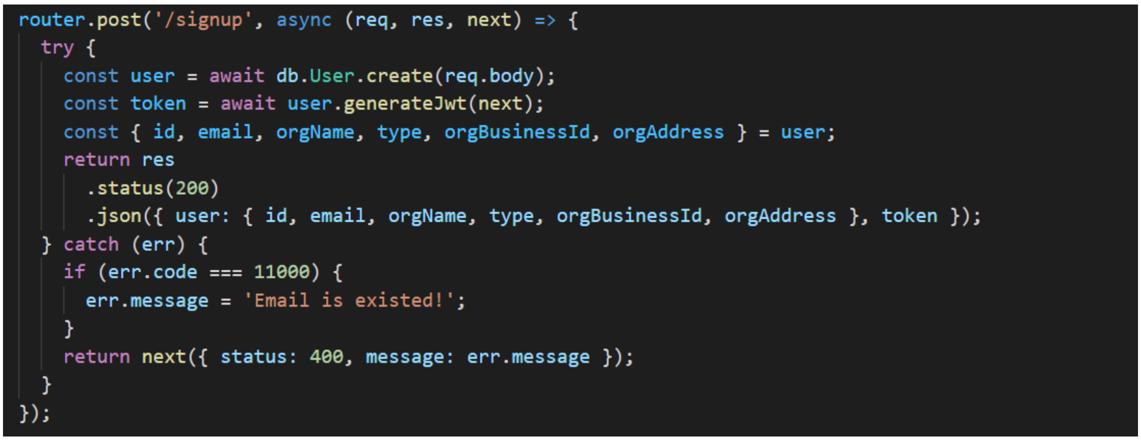


```
export const auth = (
  type: 'login' | 'signup',
  authFormData: LogInFormData | SignUpFormData,
): AppThunk => async (dispatch) => {
  try {
    dispatch(authStart());
    const auth: AxiosResponse<AuthResponse> = await axios.post(`/auth/${type}`, authFormData);
    const { token, user } = auth.data;
    setTokenHeader(token);
    saveToken(token);
    dispatch(authSuccess(user));
  } catch (e) {
    dispatch(authFail(e.response.data.error));
  }
};
```

FIGURE 19. Handling authentication in React Redux application

The authentication process starts by dispatching a state to indicate that the process has started. This information is showed on the UI with a spinner on the Sign

Up or Log In button. Then, the user input data is sent to the server via an API call, and the server responds with user information and token if the input data is valid. The token is then set to the header of future requests for authorizing the user and saving to a local storage. Finally, user information is dispatched to the Redux store to indicate that the authentication process has been completed and the user has logged in successfully.



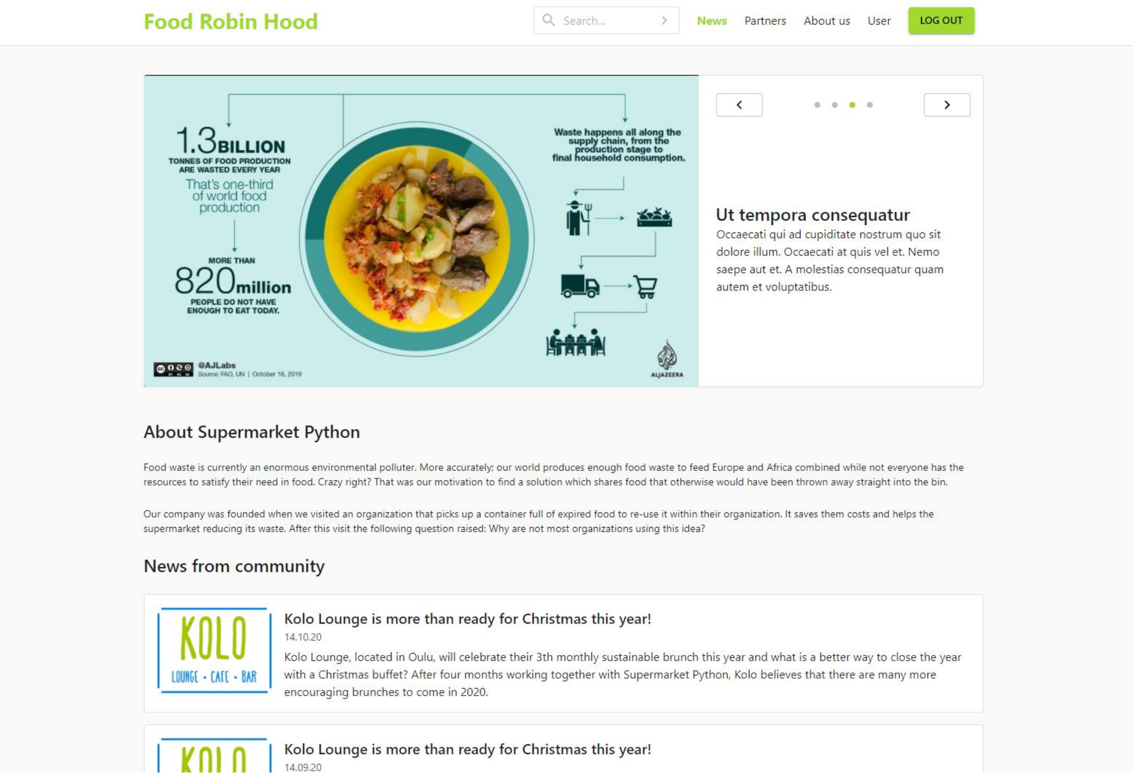
```
router.post('/signup', async (req, res, next) => {
  try {
    const user = await db.User.create(req.body);
    const token = await user.generateJwt(next);
    const { id, email, orgName, type, orgBusinessId, orgAddress } = user;
    return res
      .status(200)
      .json({ user: { id, email, orgName, type, orgBusinessId, orgAddress }, token });
  } catch (err) {
    if (err.code === 11000) {
      err.message = 'Email is existed!';
    }
    return next({ status: 400, message: err.message });
  }
});
```

FIGURE 20. The handling of user registration in Node Express server

Meanwhile, on the server-side, after receiving the client request, a new user is created with user input data together with generating a token for user authorization. The token and the user information extracted from registration are later sent back to the client for the user to log in.

7.1.2 News Feed

The News Feed page is the first page when a user accesses the application including 3 major parts: a carousel banner, a short description about the Supermarket Python Project, and a list of newsfeeds from the community. (Figure 21) The carousel banner is a slideshow that automatically switches to the next view after a specific prior setup time. This is for advertising, highlighting some news, or notifying users of important information.


Food Robin Hood
Search...
News
Partners
About us
User
LOG OUT
1.3BILLION
TONNES OF FOOD PRODUCTION ARE WASTED EVERY YEAR
That's one-third of world food production
MORE THAN
820million
PEOPLE DO NOT HAVE ENOUGH TO EAT TODAY.
Waste happens all along the supply chain, from the production stage to final household consumption.
@AJLabs
Source: FAO, UN | October 16, 2019
ALJAZEERA

Ut tempora consequatur

Occaecati qui ad cupiditate nostrum quo sit dolore illum. Occaecati at quis vel et. Nemo saepe aut et. A molestias consequatur quam autem et voluptatibus.

About Supermarket Python

Food waste is currently an enormous environmental polluter. More accurately; our world produces enough food waste to feed Europe and Africa combined while not everyone has the resources to satisfy their need in food. Crazy right? That was our motivation to find a solution which shares food that otherwise would have been thrown away straight into the bin.

Our company was founded when we visited an organization that picks up a container full of expired food to re-use it within their organization. It saves them costs and helps the supermarket reducing its waste. After this visit the following question raised: Why are not most organizations using this idea?

News from community

Kolo Lounge is more than ready for Christmas this year!

14.10.20

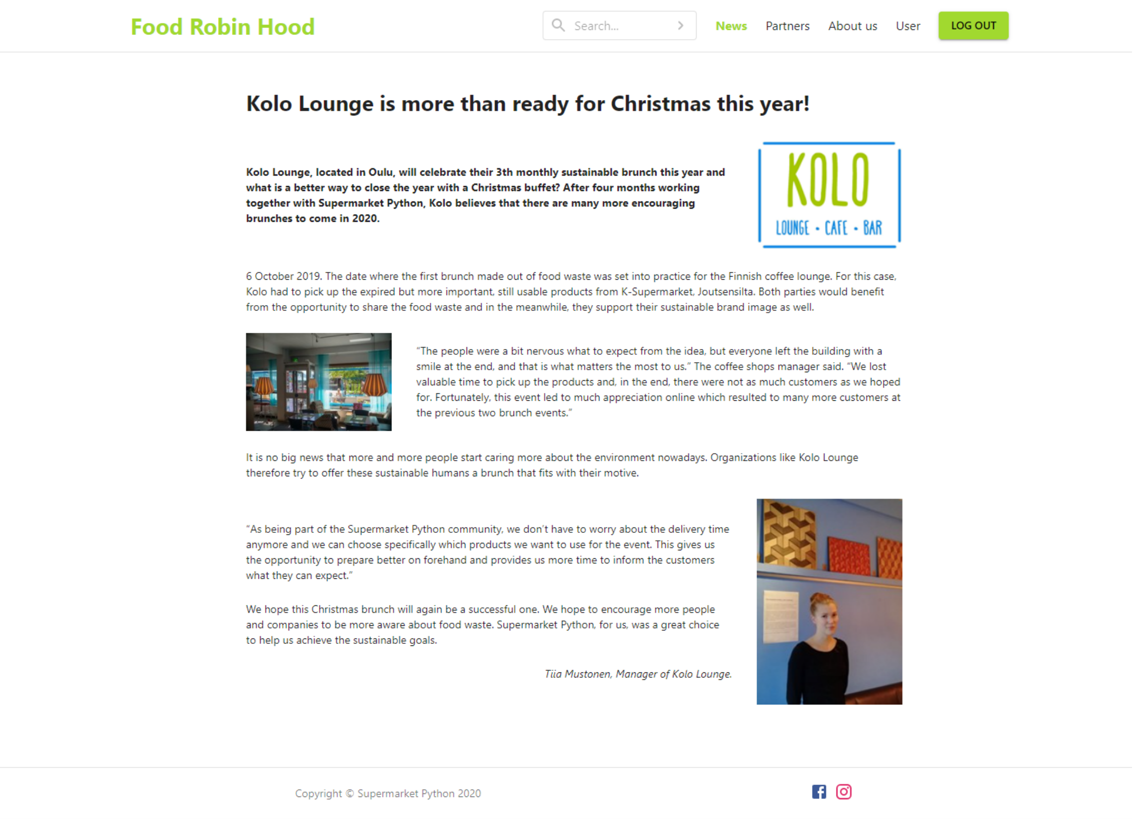
Kolo Lounge, located in Oulu, will celebrate their 3th monthly sustainable brunch this year and what is a better way to close the year with a Christmas buffet? After four months working together with Supermarket Python, Kolo believes that there are many more encouraging brunches to come in 2020.

Kolo Lounge is more than ready for Christmas this year!

14.09.20

FIGURE 21. News Feed page

Besides that, the About Supermarket Python description consists of some contents describing shortly the providing service to the user. The News From Community part comprises a news list about the Food Robin Hood community. Once the user clicks on the news, it will lead to a new page with a full article for more details. (Figure 22)



Kolo Lounge is more than ready for Christmas this year!

Kolo Lounge, located in Oulu, will celebrate their 3th monthly sustainable brunch this year and what is a better way to close the year with a Christmas buffet? After four months working together with Supermarket Python, Kolo believes that there are many more encouraging brunches to come in 2020.

6 October 2019. The date where the first brunch made out of food waste was set into practice for the Finnish coffee lounge. For this case, Kolo had to pick up the expired but more important, still usable products from K-Supermarket, Joutsensilta. Both parties would benefit from the opportunity to share the food waste and in the meanwhile, they support their sustainable brand image as well.

"The people were a bit nervous what to expect from the idea, but everyone left the building with a smile at the end, and that is what matters the most to us." The coffee shops manager said. "We lost valuable time to pick up the products and, in the end, there were not as much customers as we hoped for. Fortunately, this event led to much appreciation online which resulted to many more customers at the previous two brunch events."

It is no big news that more and more people start caring more about the environment nowadays. Organizations like Kolo Lounge therefore try to offer these sustainable humans a brunch that fits with their motive.

"As being part of the Supermarket Python community, we don't have to worry about the delivery time anymore and we can choose specifically which products we want to use for the event. This gives us the opportunity to prepare better on forehand and provides us more time to inform the customers what they can expect."

We hope this Christmas brunch will again be a successful one. We hope to encourage more people and companies to be more aware about food waste. Supermarket Python, for us, was a great choice to help us achieve the sustainable goals.

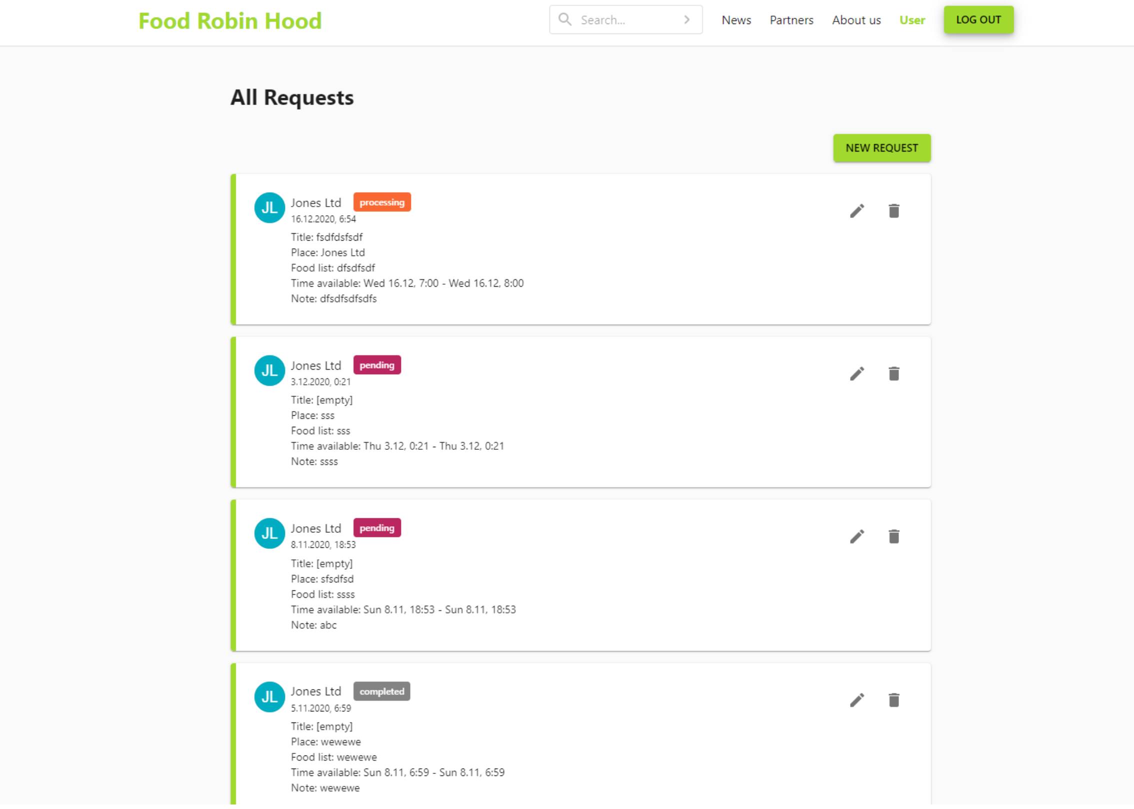
Tiia Mustonen, Manager of Kolo Lounge.

Copyright © Supermarket Python 2020

FIGURE 22. The partner's publication page

7.1.3 Food Request

Food request is one of the core features and also the most important feature in the Food Robin Hood application for solving food waste. Via this feature, supermarket users, as well as organization users including the non-profits, restaurants and cafes, and farmers, can donate or be supported with the edible food waste from the application. These requests are sent directly to the Supermarket Python Team as the admins. The user can view the history of their requests from the Food Requests page. (Figure 23)



All Requests

Jones Ltd
16.12.2020, 6:54
Title: fsdfdsfsdf
Place: Jones Ltd
Food list: dfsdfsdf
Time available: Wed 16.12, 7:00 - Wed 16.12, 8:00
Note: dfsdfsdfsdfs

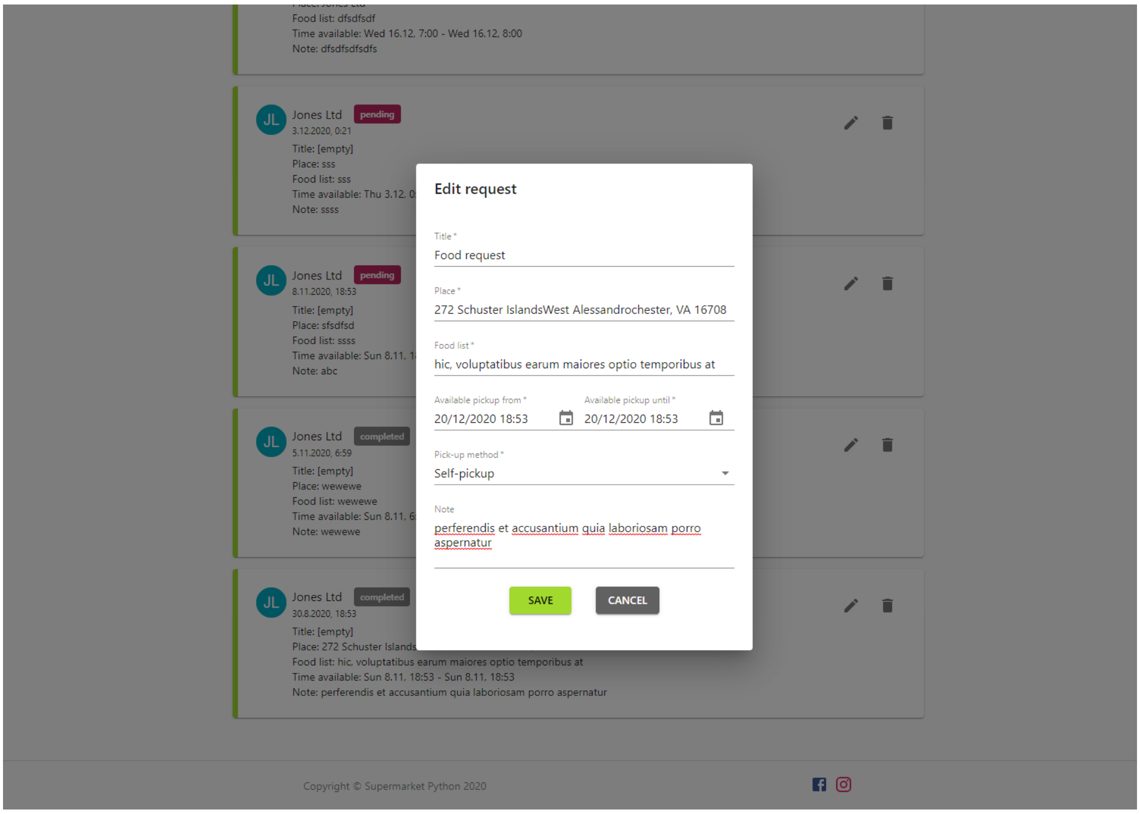
Jones Ltd
3.12.2020, 0:21
Title: [empty]
Place: sss
Food list: sss
Time available: Thu 3.12, 0:21 - Thu 3.12, 0:21
Note: ssss

Jones Ltd
8.11.2020, 18:53
Title: [empty]
Place: sfsdfsd
Food list: ssss
Time available: Sun 8.11, 18:53 - Sun 8.11, 18:53
Note: abc

Jones Ltd
5.11.2020, 6:59
Title: [empty]
Place: wewewe
Food list: wewewe
Time available: Sun 8.11, 6:59 - Sun 8.11, 6:59
Note: wewewe

FIGURE 23. Food request list

The Food Requests page is a list of requests that the user has sent to Food Robin Hood. Depending on the user type, the requests could be created to donate or be supported food. The list consists of a list of cards component in which each card displays the request information. The requests can be updated or deleted with the edit or delete icon button on each card.



Food list: dfsdfsdf
Time available: Wed 16.12, 7:00 - Wed 16.12, 8:00
Note: dfsdfsdfsdfs

JL Jones Ltd pending
3.12.2020, 0:21
Title: [empty]
Place: sss
Food list: sss
Time available: Thu 3.12, 0
Note: ssss

JL Jones Ltd pending
8.11.2020, 18:53
Title: [empty]
Place: sfsdfsd
Food list: ssss
Time available: Sun 8.11, 1
Note: abc

JL Jones Ltd completed
5.11.2020, 6:59
Title: [empty]
Place: wewewe
Food list: wewewe
Time available: Sun 8.11, 6
Note: wewewe

JL Jones Ltd completed
30.8.2020, 18:53
Title: [empty]
Place: 272 Schuster Islands
Food list: hic, voluptatibus earum maiores optio temporibus at
Time available: Sun 8.11, 18:53 - Sun 8.11, 18:53
Note: perferendis et accusantium quia laboriosam porro aspernatur

Edit request

Title *
Food request

Place *
272 Schuster IslandsWest Alessandrochester, VA 16708

Food list *
hic, voluptatibus earum maiores optio temporibus at

Available pickup from *
20/12/2020 18:53

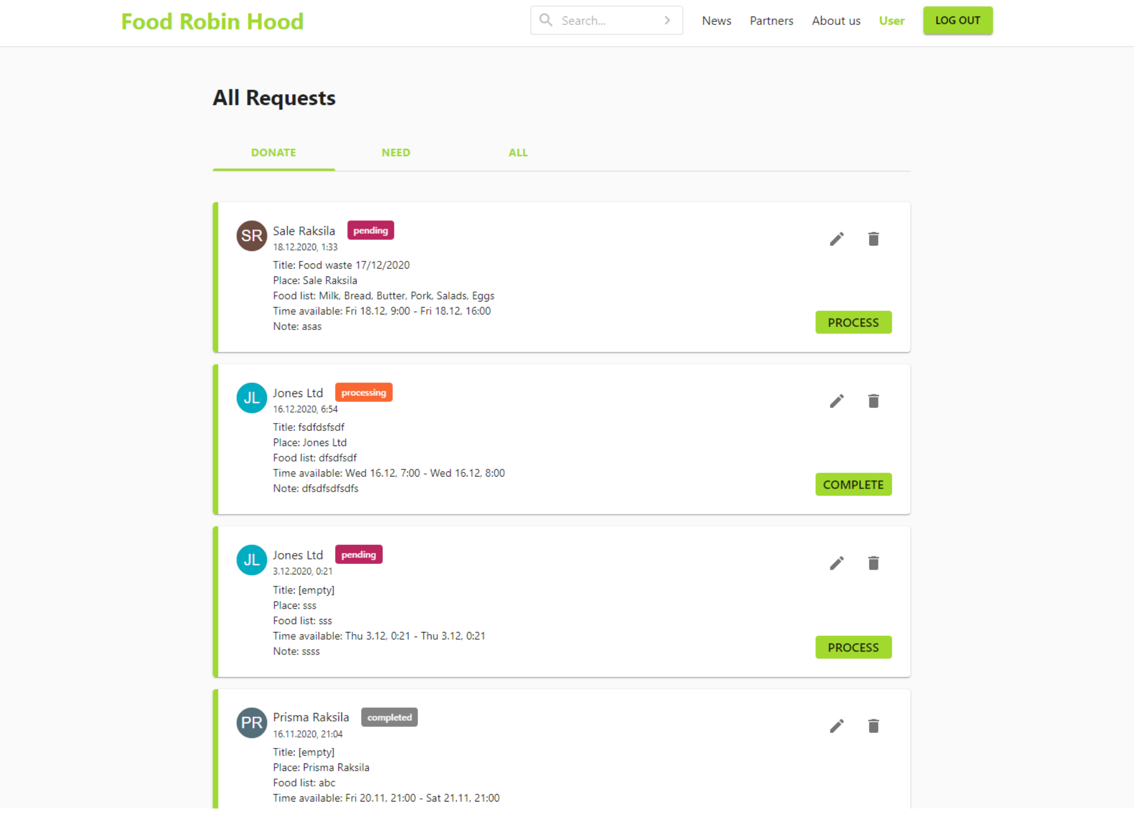
Available pickup until *
20/12/2020 18:53

Pick-up method *
Self-pickup

Note
perferendis et accusantium quia laboriosam porro aspernatur

FIGURE 24. The edit request dialog

The request card also shows the status of the request, which can appear either Pending, Processing, or Completed. When a request is created, in default it has a Pending status. The status changes to a Processing one when the administrator starts to process the request by scheduling the food delivery, or pick-up. Finally, the Completed status is updated after the process has been done. The request status can be updated and handled from an administrator account. (Figure 25)



All Requests

SR Sale Raksila pending
18.12.2020, 1:33
Title: Food waste 17/12/2020
Place: Sale Raksila
Food list: Milk, Bread, Butter, Pork, Salads, Eggs
Time available: Fri 18.12. 9:00 - Fri 18.12. 16:00
Note: asas

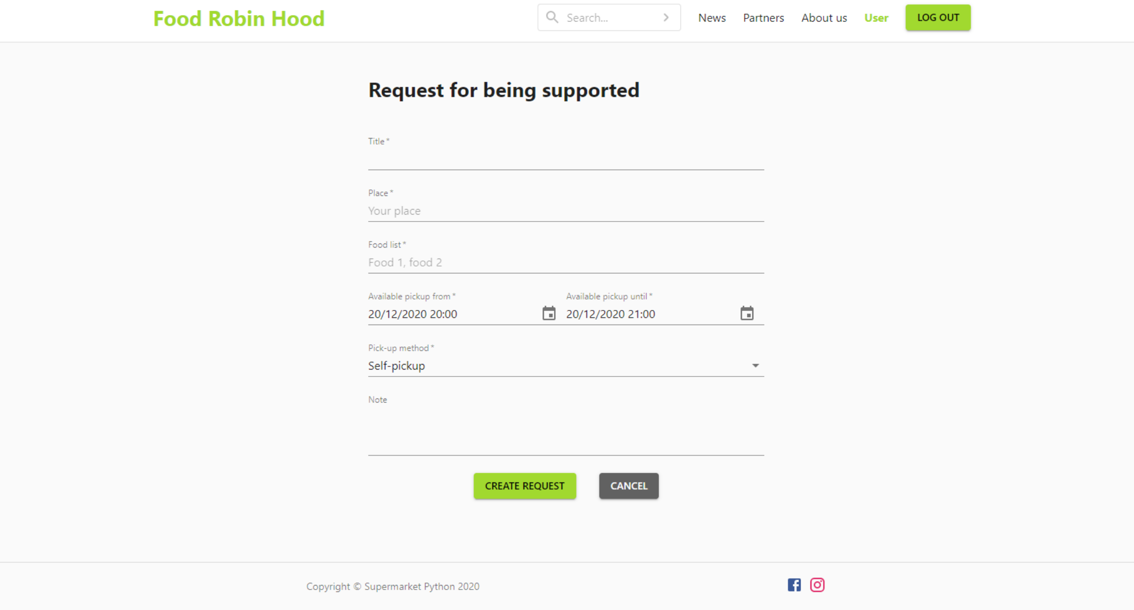
JL Jones Ltd processing
16.12.2020, 6:54
Title: fsdfdsfsdf
Place: Jones Ltd
Food list: dfsdfsdf
Time available: Wed 16.12. 7:00 - Wed 16.12. 8:00
Note: dfsdfsdfsdfs

JL Jones Ltd pending
3.12.2020, 0:21
Title: [empty]
Place: sss
Food list: sss
Time available: Thu 3.12. 0:21 - Thu 3.12. 0:21
Note: ssss

PR Prisma Raksila completed
16.11.2020, 21:04
Title: [empty]
Place: Prisma Raksila
Food list: abc
Time available: Fri 20.11. 21:00 - Sat 21.11. 21:00

FIGURE 25. Request administration view on an admin account

To create a new request, the user can click on the New Request button on the requests page or visit the Create New Requests page from the drop-down menu of User. (Figure 26)



Request for being supported

Title *

Place *
Your place

Food list *
Food 1, food 2

Available pickup from *
20/12/2020 20:00

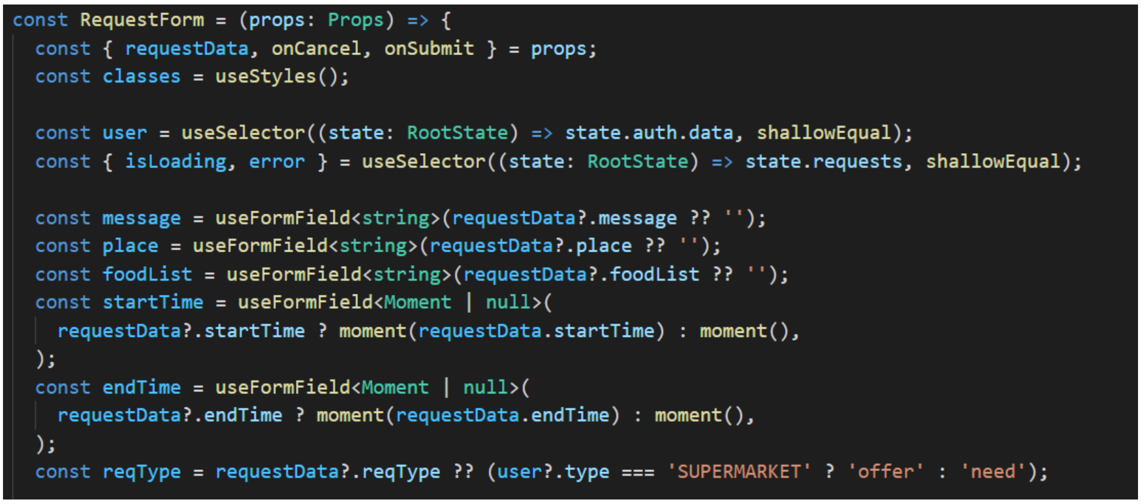
Available pickup until *
20/12/2020 21:00

Pick-up method *
Self-pickup

Note

FIGURE 26. The Create New Request page

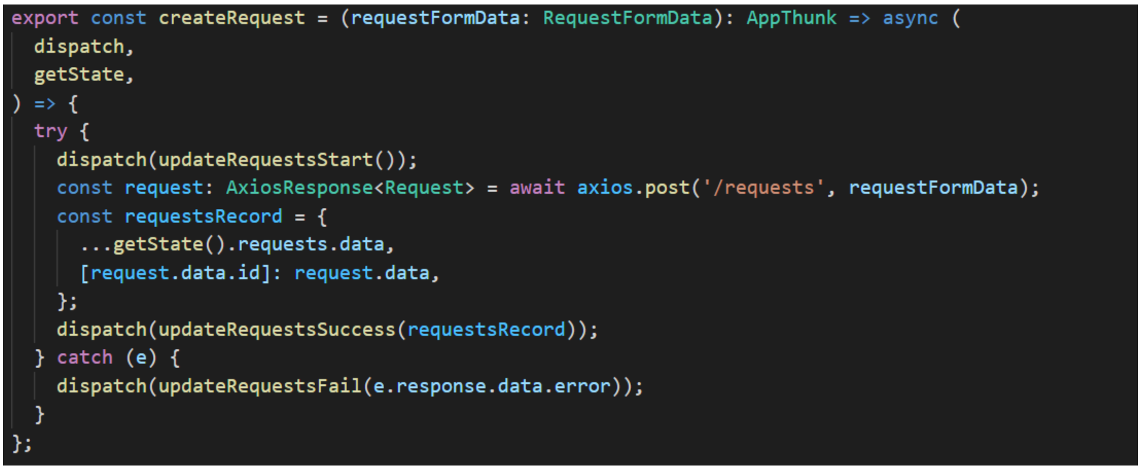
On the development side, the edit and create new request functions dynamically use the same request form component. If an existing request data is provided to the components, it shows as the edit view. Otherwise, it shows as the create new request view. (Figure 27)



```
const RequestForm = (props: Props) => {
  const { requestData, onCancel, onSubmit } = props;
  const classes = useStyles();

  const user = useSelector((state: RootState) => state.auth.data, shallowEqual);
  const { isLoading, error } = useSelector((state: RootState) => state.requests, shallowEqual);

  const message = useFormField<string>(requestData?.message ?? '');
  const place = useFormField<string>(requestData?.place ?? '');
  const foodList = useFormField<string>(requestData?.foodList ?? '');
  const startTime = useFormField<Moment | null>(
    requestData?.startTime ? moment(requestData.startTime) : moment(),
  );
  const endTime = useFormField<Moment | null>(
    requestData?.endTime ? moment(requestData.endTime) : moment(),
  );
  const reqType = requestData?.reqType ?? (user?.type === 'SUPERMARKET' ? 'offer' : 'need');
```

FIGURE 27. RequestForm component

After the user has input the request form data and clicked the Create Request button, the request is handled on the client-side by a Redux Thunk action. Firstly, it updates the states to indicate that the request is being processed. Secondly, it sends the request data to the server via an API with the POST method. After the server creates and saves the request to the database, it responds to the client with the data of the newly created request. Finally, the action dispatches the new request data to the Redux state to display on the requests page. (Figure 28)



```
export const createRequest = (requestFormData: RequestFormData): AppThunk => async (
  dispatch,
  getState,
) => {
  try {
    dispatch(updateRequestsStart());
    const request: AxiosResponse<Request> = await axios.post('/requests', requestFormData);
    const requestsRecord = {
      ...getState().requests.data,
      [request.data.id]: request.data,
    };
    dispatch(updateRequestsSuccess(requestsRecord));
  } catch (e) {
    dispatch(updateRequestsFail(e.response.data.error));
  }
};
```

FIGURE 28. Create request Redux Thunk action

7.1.4 Searching

Searching is a primary feature for getting most of the applications. The user can search for supermarkets or organizations from the search input field in the navigation bar as showing in figure 29 below.

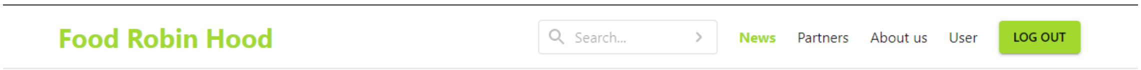
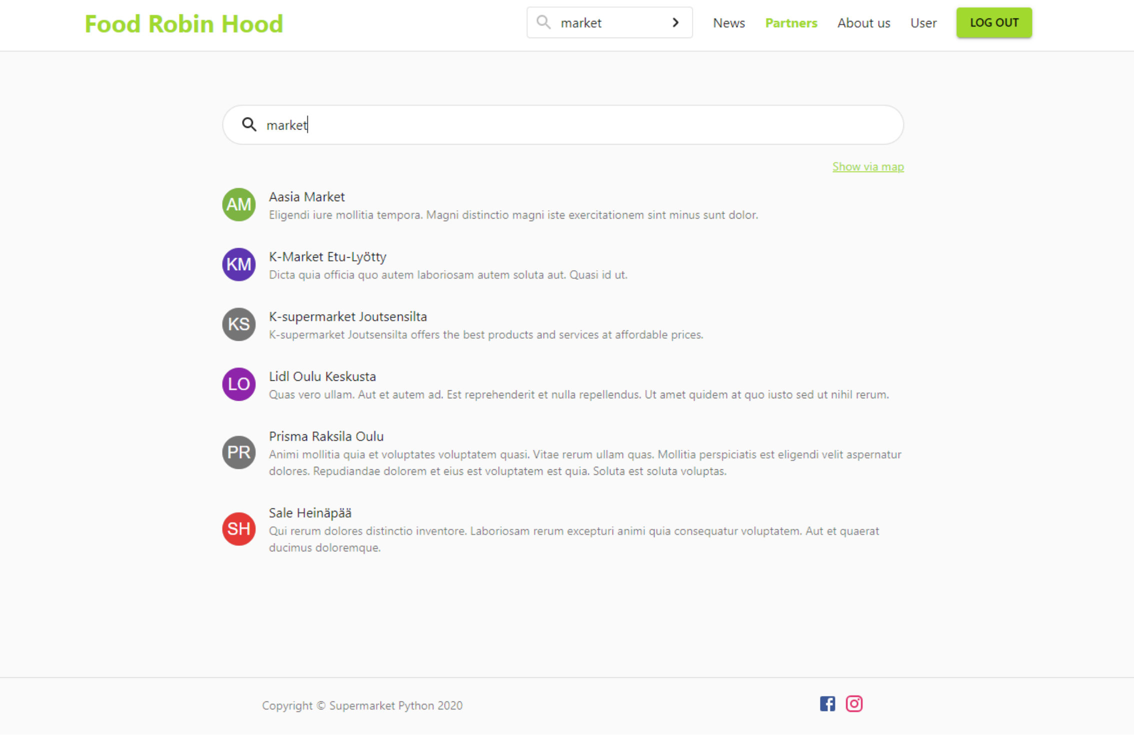


FIGURE 29. Search input field from the navigation bar

After inputting and pressing the enter or click the “>” button, the search results will be displayed on the search page. The Search page also shows the search input field for the convenience of the user if the user would like to make another search. The Show Via Map link below the search input field is designed in case the user would like to see the location of the supermarkets or organizations exactly on the map.



Aasia Market
Eligendi iure mollitia tempora. Magni distinctio magni iste exercitationem sint minus sunt dolor.

K-Market Etu-Lyötty
Dicta quia officia quo autem laboriosam autem soluta aut. Quasi id ut.

K-supermarket Joutsensilta
K-supermarket Joutsensilta offers the best products and services at affordable prices.

Lidl Oulu Keskusta
Quas vero ullam. Aut et autem ad. Est reprehenderit et nulla repellendus. Ut amet quidem at quo iusto sed ut nihil rerum.

Prisma Raksila Oulu
Animi mollitia quia et voluptates voluptatem quasi. Vitae rerum ullam quas. Mollitia perspiciatis est eligendi velit aspernatur dolores. Repudiandae dolorem et eius est voluptatem est quia. Soluta est soluta voluptas.

Sale Heinäpää
Qui rerum dolores distinctio inventore. Laboriosam rerum excepturi animi quia consequatur voluptatem. Aut et quaerat ducimus doloremque.

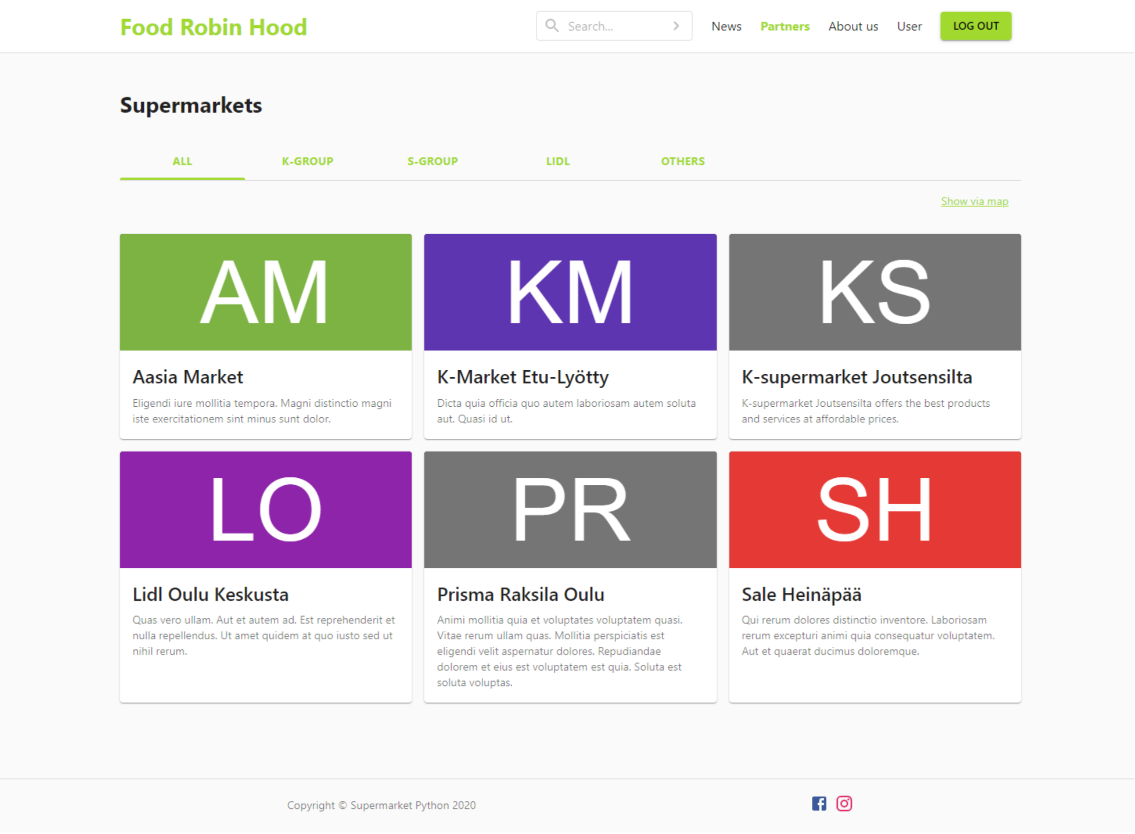
Copyright © Supermarket Python 2020

FIGURE 30. Search result page

7.1.5 Locating Partners via Map

Besides searching, all the partners which are registered users in the Food Robin Hood are published on the Partners page by the Supermarket Python Team as strategic partners regarding the compromise. They are filtered and listed by different groups on the Partners' page. The user can see separate lists for Supermarkets, Non-profit organizations, Restaurants and Cafes, or Farmers from the Partners' drop-down in the navigation bar.

On the Partners' page, partners are also grouped into different categories depending on the organization types. For example, on the Supermarkets page, supermarkets are gathered into K-Group, S-Group, Lidl, or others. The location of partners can be viewed on the map via the Show Via Map link. (Figure 31)



Supermarkets

Aasia Market

Eligendi iure mollitia tempora. Magni distinctio magni iste exercitationem sint minus sunt dolor.

K-Market Etu-Lyötty

Dicta quia officia quo autem laboriosam autem soluta aut. Quasi id ut.

K-supermarket Joutsensilta

K-supermarket Joutsensilta offers the best products and services at affordable prices.

Lidl Oulu Keskusta

Quas vero ullam. Aut et autem ad. Est reprehenderit et nulla repellendus. Ut amet quidem at quo iusto sed ut nihil rerum.

Prisma Raksila Oulu

Animi mollitia quia et voluptates voluptatem quasi. Vitae rerum ullam quas. Mollitia perspiciatis est eligendi velit aspernatur dolores. Repudiandae dolorem et eius est voluptatem est quia. Soluta est soluta voluptas.

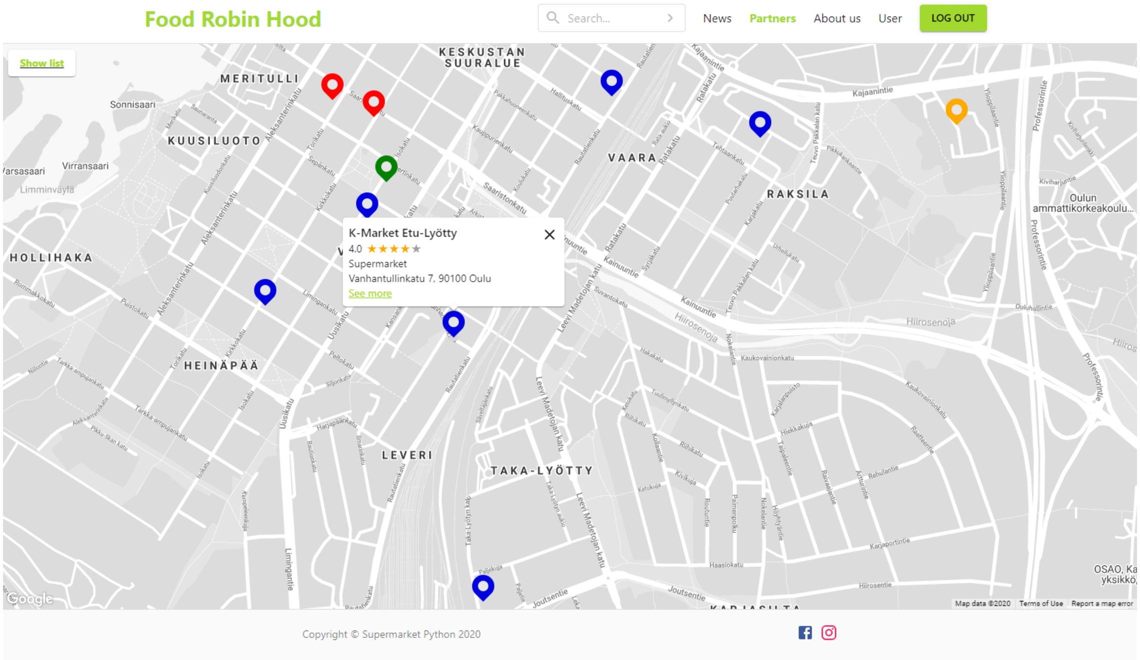
Sale Heinäpää

Qui rerum dolores distinctio inventore. Laboriosam rerum excepturi animi quia consequatur voluptatem. Aut et quaerat ducimus doloremque.

Copyright © Supermarket Python 2020

FIGURE 31. Partners page view

The map can be accessed from the “Show via map” link on the Search page or the Partners page. From the map, the user can go back to the previous view by choosing the Show List button on the top left of the map. (Figure 32) Each user, which is also known as the partner, is marked with a pin on the map with different colors depending on the user type. By clicking on a pin (as a partner), a small pop-up appears to show brief information about the partner, such as name, rating, user type, address, and a link to the detailed page of the partner.

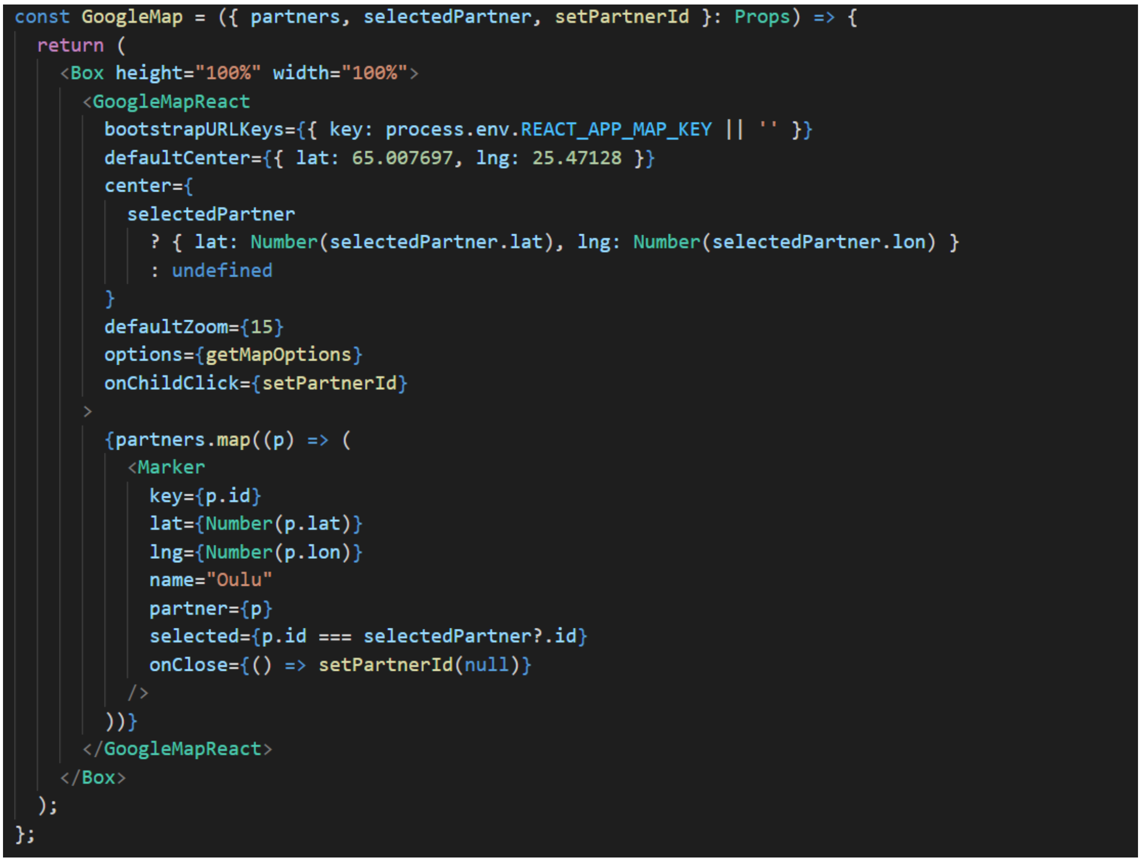


K-Market Etu-Lyötty
4.0 ★★★★★
Supermarket
Vanhantullinkatu 7, 90100 Oulu
See more

Copyright © Supermarket Python 2020

FIGURE 32. Locations via Map view

The Map feature is implemented with Google Map APIs and the google-map-react library. The google-map-react provides a GoogleMapReact component that wraps all needed APIs under React props. The Map API key is created and configured from the Google Cloud Platform dashboard. (Figure 33)

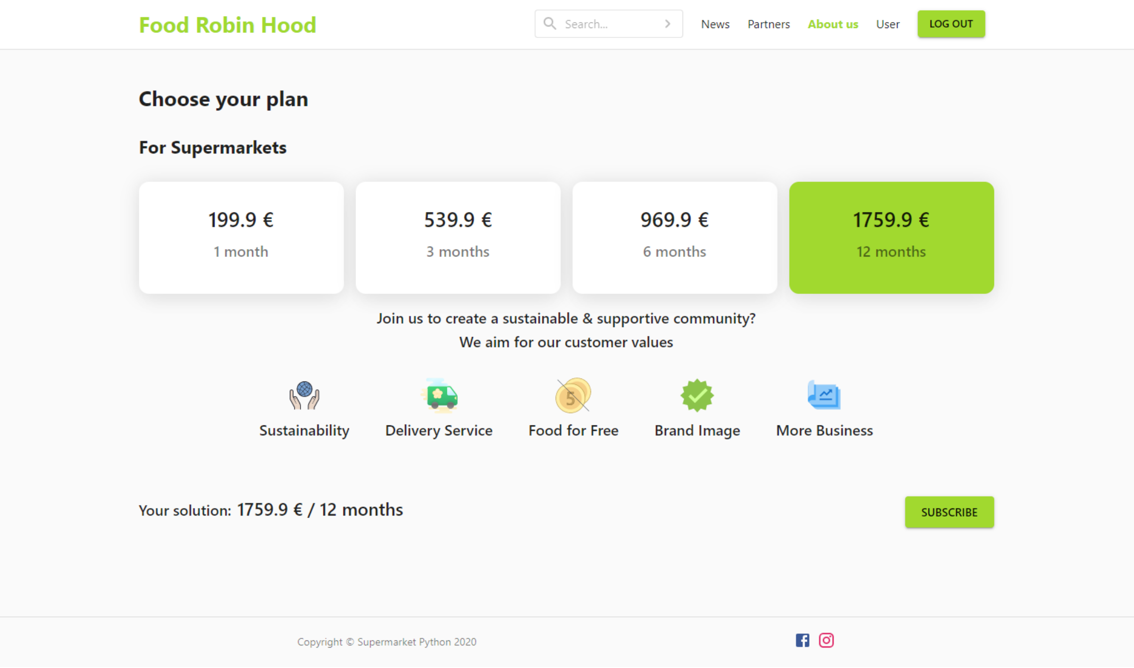


```
const GoogleMap = ({ partners, selectedPartner, setPartnerId }: Props) => {
  return (
    <Box height="100%" width="100%">
      <GoogleMapReact
        bootstrapURLKeys={{ key: process.env.REACT_APP_MAP_KEY || '' }}
        defaultCenter={{ lat: 65.007697, lng: 25.47128 }}
        center={
          selectedPartner
            ? { lat: Number(selectedPartner.lat), lng: Number(selectedPartner.lon) }
            : undefined
        }
        defaultZoom={15}
        options={getMapOptions}
        onChildClick={setPartnerId}
      >
        {partners.map((p) => (
          <Marker
            key={p.id}
            lat={Number(p.lat)}
            lng={Number(p.lon)}
            name="Oulu"
            partner={p}
            selected={p.id === selectedPartner?.id}
            onClose={() => setPartnerId(null)}
          />
        ))}
      </GoogleMapReact>
    </Box>
  );
};
```

FIGURE 33. The Map component

7.1.6 Payment

Payment is also an essential feature that enables Supermarket Python services into operation. The enablement of online payment is designed for the most convenient and rapid for users. However, one of the most concern about the payment function is security. Additionally, handling security requires much more resources, and the billing process itself is also very complicated.



Choose your plan

For Supermarkets

199.9 €	539.9 €	969.9 €	1759.9 €
1 month	3 months	6 months	12 months

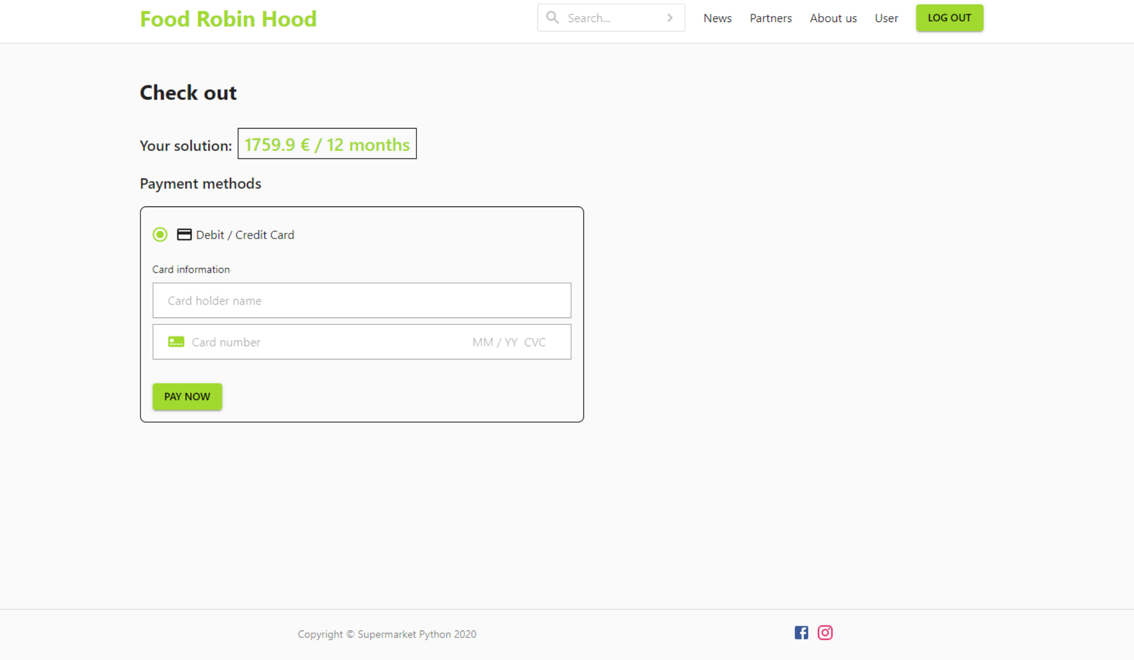
Join us to create a sustainable & supportive community?
We aim for our customer values

Your solution: 1759.9 € / 12 months

Copyright © Supermarket Python 2020

FIGURE 34. The view of the Subscription page for the user with different bundles

Hence, using a third-party payment processor is preferred in most small and medium-sized companies, especially for startups. Due to the above concerns, Stripe will be used as the payment processor in the Food Robin Hood application. Stripe provides many payment options for the end-user, such as a credit card, Google Pay, Apple Pay, and local banks. For the scope of this thesis under the limit of time, the payment method with credit cards will be implemented only. (Figure 35)



Check out

Your solution: 1759.9 € / 12 months

Payment methods

● Debit / Credit Card

Card information

Card holder name

Card number MM / YY CVC

FIGURE 35. The Checkout page with Debit / Credit Card payment

Once the user clicks on the Subscribe button on the Pricings page, it turns to the Payment page to start the checkout process. On the Payment page, the order summary is summed and listed, then Stripe will generate a credit card form automatically. At any time, the actual credit card detail will be handled separately and securely by the Stripe credit card form itself. Thus, the credit card details are not handled, interacted with, or kept in the Food Robin Hood application.

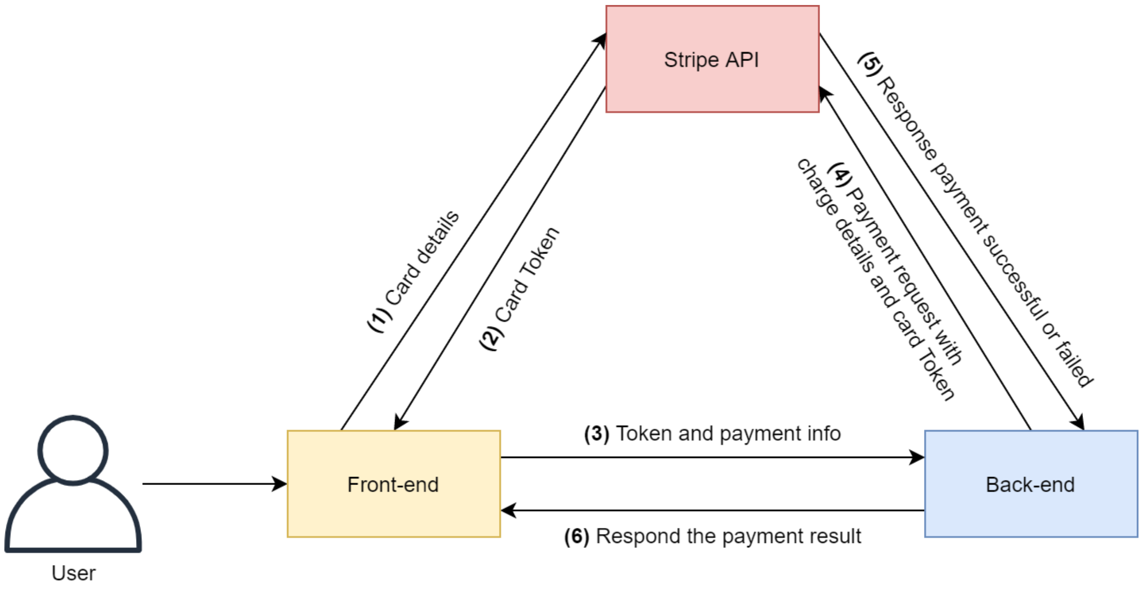
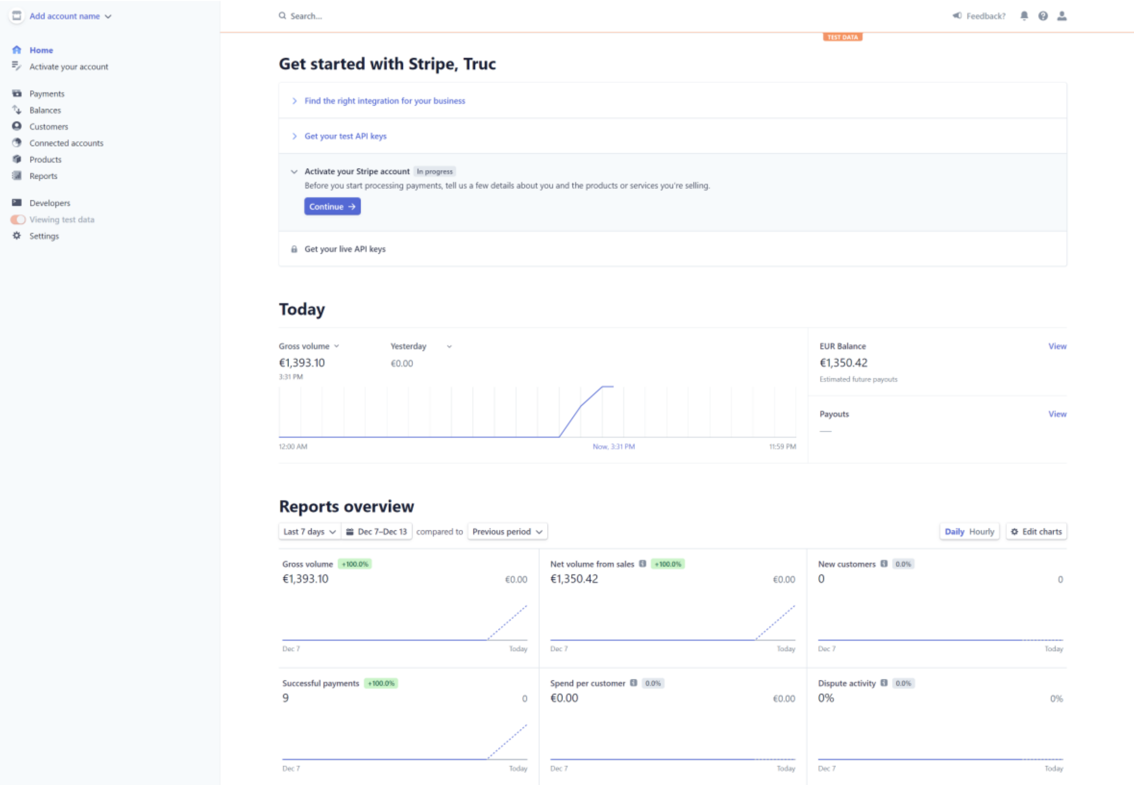

Stripe API
(1) Card details
(2) Card Token
(4) Payment request with charge details and card Token
(5) Response payment successful or failed
User
Front-end
Back-end
(3) Token and payment info
(6) Respond the payment result

FIGURE 36. The payment process with the Stripe API

After the user provides credit card details and clicks the Pay button, the payment process will start by sending card details to the Stripe API from the front-end. Then, when these details are sent to the Stripe API, Stripe will respond with a token object that represents the card. Next, the front-end will send that token with other data related to the purchase to the back-end API. The back-end will make a follow-up request over to the Stripe API and receive the response from Stripe whether the payment is successful or failed. If the payment is successful, the subscription or purchased info will be saved into the user account. Finally, the server responses back to the front-end about the payment result. (Figure 36)



Get started with Stripe, Truc

Find the right integration for your business

Get your test API keys

Activate your Stripe account In progress

Before you start processing payments, tell us a few details about you and the products or services you're selling.

Get your live API keys

Today

Gross volume €1,393.10 3:31 PM

Yesterday €0.00

12:00 AM Now, 3:31 PM 11:59 PM

EUR Balance €1,350.42 Estimated future payouts

Payouts —

Reports overview

Last 7 days | Dec 7–Dec 13 | compared to | Previous period

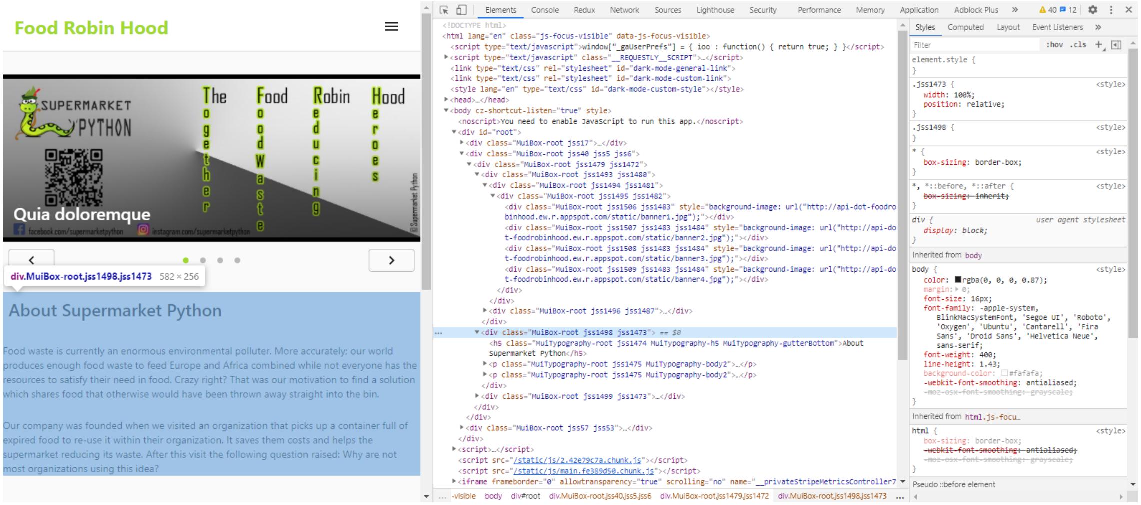
Metric	Change	Value	Previous	From	To
Gross volume	+100.0%	€1,393.10	€0.00	Dec 7	Today
Net volume from sales	+100.0%	€1,350.42	€0.00	Dec 7	Today
New customers	0.0%	0	0	Dec 7	Today
Successful payments	+100.0%	9	0	Dec 7	Today
Spend per customer	0.0%	€0.00	€0.00	Dec 7	Today
Dispute activity	0.0%	0%	0%	Dec 7	Today

FIGURE 37. Stripe dashboard with API keys and report overview

In the Stripe dashboard, we can easily register the API keys that will be used to authenticate the application with Stripe. The dashboard also provides a comprehensive reports overview of all the payments. (Figure 37)

7.2 Debugging

Debugging is one of the most fundamental things in web development, and debugging tools play a key role in the process. The most ideal option is developing an application that is compatible with cross-browser for a better UX, yet starting with Google Chrome is also a good choice. Apart from being the preferable browser for both desktop and mobile devices, Chrome is also packaged with an exceptionally good developer tool for debugging. Chrome's devtool provides numerous built-in functionalities together with the ability to extend with other plugins, such as React devtool or Redux devtool. (Figure 38)



About Supermarket Python

Food waste is currently an enormous environmental polluter. More accurately; our world produces enough food waste to feed Europe and Africa combined while not everyone has the resources to satisfy their need in food. Crazy right? That was our motivation to find a solution which shares food that otherwise would have been thrown away straight into the bin.

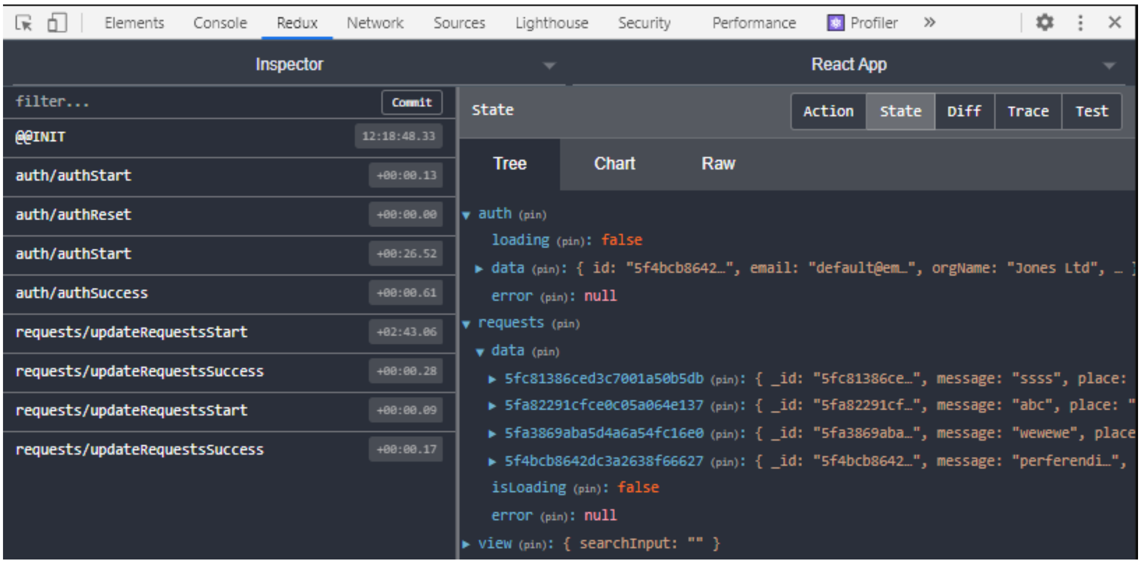
Our company was founded when we visited an organization that picks up a container full of expired food to re-use it within their organization. It saves them costs and helps the supermarket reducing its waste. After this visit the following question raised: Why are not most organizations using this idea?

```
<!DOCTYPE html>
<html lang="en" class="js-focus-visible" data-js-focus-visible>
  <script type="text/javascript">window["_gaUserPrefs"] = { ioo : function() { return true; } }</script>
 ▸<script type="text/javascript" class="__REQUESTLY__SCRIPT">…</script>
  <link type="text/css" rel="stylesheet" id="dark-mode-general-link">
  <link type="text/css" rel="stylesheet" id="dark-mode-custom-link">
  <style lang="en" type="text/css" id="dark-mode-custom-style"></style>
 ▸<head>…</head>
 ▾<body cz-shortcut-listen="true" style>
    <noscript>You need to enable JavaScript to run this app.</noscript>
   ▾<div id="root">
     ▸<div class="MuiBox-root jss17">…</div>
     ▾<div class="MuiBox-root jss40 jss5 jss6">
       ▾<div class="MuiBox-root jss1479 jss1472">
         ▾<div class="MuiBox-root jss1493 jss1480">
           ▾<div class="MuiBox-root jss1494 jss1481">
             ▾<div class="MuiBox-root jss1495 jss1482">
                <div class="MuiBox-root jss1506 jss1483" style="background-image: url("http://api-dot-foodro
                binhood.ew.r.appspot.com/static/banner1.jpg");"></div>
                <div class="MuiBox-root jss1507 jss1483 jss1484" style="background-image: url("http://api-do
                t-foodrobinhood.ew.r.appspot.com/static/banner2.jpg");"></div>
                <div class="MuiBox-root jss1508 jss1483 jss1484" style="background-image: url("http://api-do
                t-foodrobinhood.ew.r.appspot.com/static/banner3.jpg");"></div>
                <div class="MuiBox-root jss1509 jss1483 jss1484" style="background-image: url("http://api-do
                t-foodrobinhood.ew.r.appspot.com/static/banner4.jpg");"></div>
              </div>
            </div>
           ▸<div class="MuiBox-root jss1496 jss1487">…</div>
          </div>
…        ▾<div class="MuiBox-root jss1498 jss1473"> == $0
            <h5 class="MuiTypography-root jss1474 MuiTypography-h5 MuiTypography-gutterBottom">About
            Supermarket Python</h5>
           ▸<p class="MuiTypography-root jss1475 MuiTypography-body2">…</p>
           ▸<p class="MuiTypography-root jss1475 MuiTypography-body2">…</p>
          </div>
         ▸<div class="MuiBox-root jss1499 jss1473">…</div>
        </div>
      </div>
     ▸<div class="MuiBox-root jss57 jss53">…</div>
    </div>
   ▸<script>…</script>
    <script src="/static/js/2.42e79c7a.chunk.js"></script>
    <script src="/static/js/main.fe389d50.chunk.js"></script>
   ▸<iframe frameborder="0" allowtransparency="true" scrolling="no" name="__privateStripeMetricsController7
… -visible  body  div#root  div.MuiBox-root.jss40.jss5.jss6  div.MuiBox-root.jss1479.jss1472  div.MuiBox-root.jss1498.jss1473 …
```

```
element.style {
}
.jss1473 {                                   <style>
  width: 100%;
  position: relative;
}
.jss1498 {                                   <style>
}
* {                                          <style>
  box-sizing: border-box;
}
*, *::before, *::after {                     <style>
  ~~box-sizing: inherit;~~
}
div {                          user agent stylesheet
  display: block;
}
Inherited from body
body {                                       <style>
  color: ■rgba(0, 0, 0, 0.87);
  margin: ▸ 0;
  font-size: 16px;
  font-family: -apple-system,
     BlinkMacSystemFont, 'Segoe UI', 'Roboto',
     'Oxygen', 'Ubuntu', 'Cantarell', 'Fira
     Sans', 'Droid Sans', 'Helvetica Neue',
     sans-serif;
  font-weight: 400;
  line-height: 1.43;
  background-color: □#fafafa;
  -webkit-font-smoothing: antialiased;
  ~~-moz-osx-font-smoothing: grayscale;~~
}
Inherited from html.js-focu…
html {                                       <style>
  box-sizing: border-box;
  ~~-webkit-font-smoothing: antialiased;~~
  ~~-moz-osx-font-smoothing: grayscale;~~
}
Pseudo ::before element
```

FIGURE 38. Google Chrome’s developer tools

Working with Redux introduces bugs while implementing the Redux store and states to use through the application. Moreover, Redux devtool is indispensable for navigating between states and easily finding out prevailing flaws.



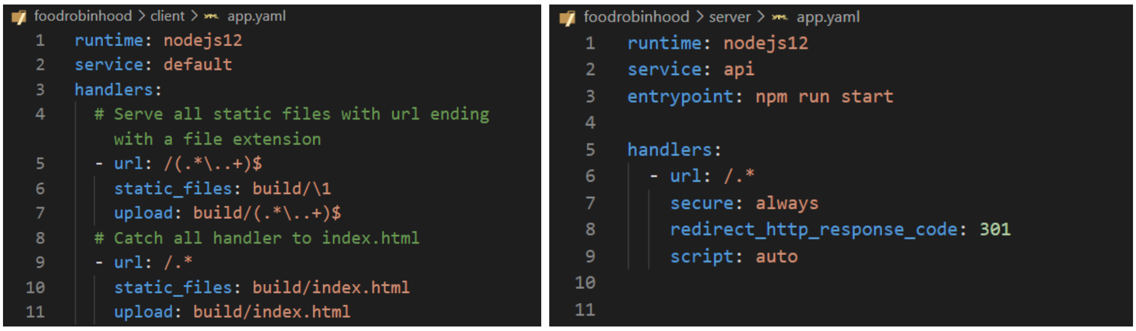
```
@@INIT                               12:18:48.33
auth/authStart                       +00:00.13
auth/authReset                       +00:00.00
auth/authStart                       +00:26.52
auth/authSuccess                     +00:00.61
requests/updateRequestsStart         +02:43.06
requests/updateRequestsSuccess       +00:00.28
requests/updateRequestsStart         +00:00.09
requests/updateRequestsSuccess       +00:00.17
```

```
▾ auth (pin)
   loading (pin): false
 ▸ data (pin): { id: "5f4bcb8642…", email: "default@em…", orgName: "Jones Ltd", … }
   error (pin): null
▾ requests (pin)
 ▾ data (pin)
   ▸ 5fc81386ced3c7001a50b5db (pin): { _id: "5fc81386ce…", message: "ssss", place:
   ▸ 5fa82291cfce0c05a064e137 (pin): { _id: "5fa82291cf…", message: "abc", place: "
   ▸ 5fa3869aba5d4a6a54fc16e0 (pin): { _id: "5fa3869aba…", message: "wewewe", place
   ▸ 5f4bcb8642dc3a2638f66627 (pin): { _id: "5f4bcb8642…", message: "perferendi…",
   isLoading (pin): false
   error (pin): null
▸ view (pin): { searchInput: "" }
```

FIGURE 39. Redux devtool on Google Chrome

7.3 Deployment

In this section, the deployment process will be discussed. For the best of scalability, flexibility, and simplicity, the Google App Engine was applied for the deployment of the Food Robin Hood. The Google App Engine is a fully managed environment that manages all the infrastructure concerns to let the developer focus on implementing features that matter. It supports different programming languages, works based on microservices architecture, and automatically scales based on the workload.


foodrobinhood > client > app.yaml
foodrobinhood > server > app.yaml

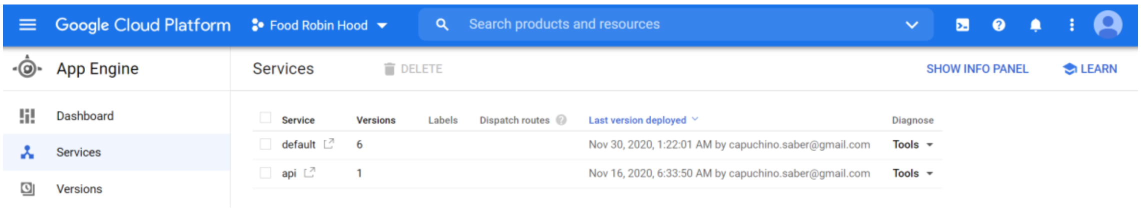
```yaml
runtime: nodejs12
service: default
handlers:
  # Serve all static files with url ending with a file extension
  - url: /(.*\..+)$
    static_files: build/\1
    upload: build/(.*\..+)$
  # Catch all handler to index.html
  - url: /.*
    static_files: build/index.html
    upload: build/index.html
```

```yaml
runtime: nodejs12
service: api
entrypoint: npm run start

handlers:
  - url: /.*
    secure: always
    redirect_http_response_code: 301
    script: auto

```

FIGURE 40. Client and server deployment configuration files

The client and server are deployed as 2 different services. The deployment is configured by a YAML file for each service. The configuration comprises the runtime environment, service name, handlers for routing, and the entry command to start the service if needed. (Figure 40) After that, the deployment would be done with a command:

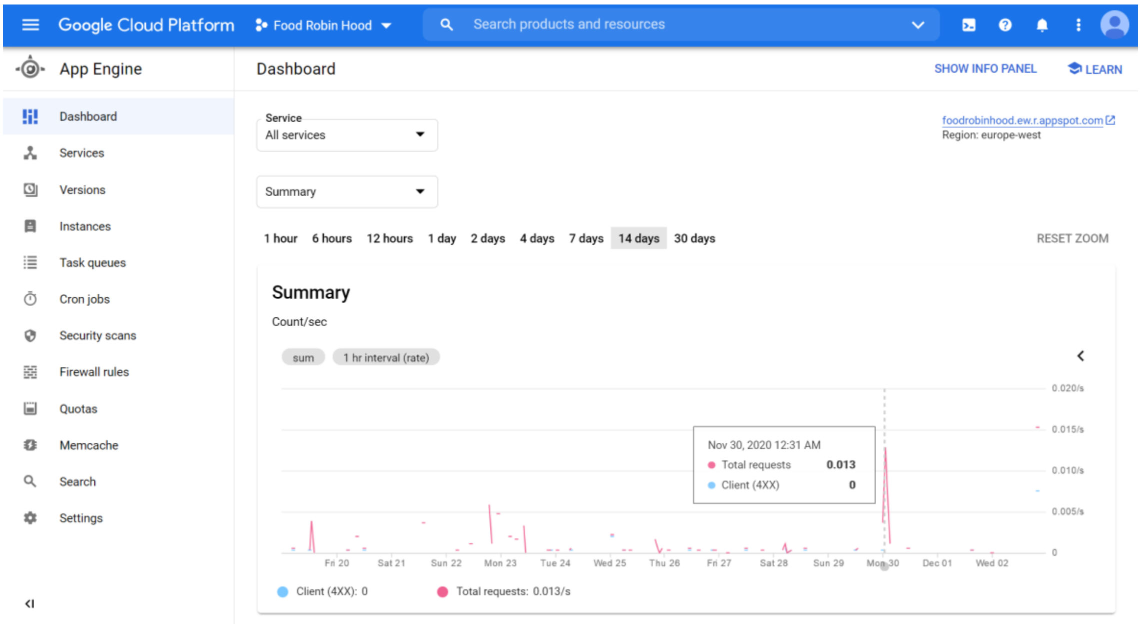
gcloud app deploy --project <project-id>



□	Service	Versions	Labels	Dispatch routes	Last version deployed	Diagnose
□	default	6			Nov 30, 2020, 1:22:01 AM by capuchino.saber@gmail.com	Tools
□	api	1			Nov 16, 2020, 6:33:50 AM by capuchino.saber@gmail.com	Tools

FIGURE 41. Deployed services on Google Cloud Platform

The services after deployed completely will appear and could be monitored through the Google Cloud Platform dashboard as in figures 41 and 42.



Dashboard

Service
All services

Summary

foodrobinhood.ew.r.appspot.com
Region: europe-west

Summary
Count/sec

Nov 30, 2020 12:31 AM
Total requests 0.013
Client (4XX) 0

Client (4XX): 0
Total requests: 0.013/s

FIGURE 42. Google App Engine dashboard

8 CONCLUSION

In summary, this thesis named Food Robin Hood aimed to develop a fully-featured demo web application as the initial step of Supermarket Python's service. Moreover, this thesis also completed the researched parts as the panorama of food waste in Finland for further developments in the future. The Food Robin Hood application then was formed and developed from the idea and fundamentals of the mother project – Supermarket Python which was oriented towards a unique, but efficient and sustainable food waste solution for supermarkets in Finland.

Therefore, to create a convenient, speedy, simple, friendly, and secure application regarding the project orientation, the modern web technologies, for instance, the MERN stack plus TypeScript programming language, were applied to the Food Robin Hood for the feasibility and viability of the project. The coherence of the modern web technologies used altogether in this thesis brought a high efficiency to the system reported as a learning diary. Thus, with an effort of applying the newest technologies, for example, the Redux Toolkit, the application was done and deployed via the Google Cloud Platform as a public site with full features as the requirements and the targeted UI for the B2B users.

Additionally, this thesis also followed the SDLC to ensure the working process and give the best results for the project. In a real-life situation notwithstanding, the Requests for donating or receiving food should be handled and processed by Supermarket Python after created on the system. Otherwise, all requests would appear as a pending status, not yet processed. Hence, in the limitation of the demo application, the administrator was created temporarily to deal with the above-mentioned problem instead.

Also, while developing the Food Robin Hood, Mapping and Payment features were pretty challenging to accomplish since the application of new technologies was acquired. Yet, the use of third-party APIs, such as a Google Map API and a Stripe API, contributed much to developing those features. Then, with the project objective to meet a large number of users in the future, the database design for the system underneath was also important for the later application expansion.

For a further development discussion, due to the thesis limited on the application only, the research part needs the deeper analysis and discussion deeper about the use of edible food waste under the hygienic regulations. Secondly, about the application, for higher securities and strictness as a real-life application, the user profile should be checked against fake users by the validation of business IDs. Furthermore, the Payment feature should be developed with more payment methods in the future for user convenience.

In conclusion, the Food Robin Hood application has not been completed perfectly, yet adequately with full features as listed and all the technical points were achieved. Besides, this thesis with the research part in the overview of food waste picture in Finland was considered the beginning for other projects aiming for better efficient solutions to food waste in Finland and would promise a zero-food-waste society in the future.

REFERENCES

1. United Nations. 2020. Goal 12: Ensure sustainable consumption and production patterns. Date of retrieval 20.9.2020. https://www.un.org/sustainabledevelopment/sustainable-consumption-production/.

2. Hietala S., Riipi I., Välimaa A.-L, Katajajuuri J.-M. 2018. Food waste reduction by developing legislation. Government’s analysis, assessment and research activities. Date of retrieval 20.9.2020 https://valtioneuvosto.fi/documents/1927382/2116852/9-2018-Food+waste+reduction+by+developing+legislation/713f019b-8b05-43c6-bfbd-5423706fadde?version=1.0.

3. Editorial Team. 2019. Finland aims to halve food losses by 2030; Finnish model on display in Brussels. Date of retrieval 20.9.2020 https://finlandtoday.fi/finland-aims-to-halve-food-losses-by-2030-finnish-model-on-display-in-brussels/

4. Osazee, O. 2019. Reducing and reselling food waste: Case BarLaurea Restaurant. Date of retrieval 16.10.2020. https://www.theseus.fi/bitstream/handle/10024/161578/Osazee_Odion.pdf?sequence=2&isAllowed=y

5. Silvennoinen, K. 2020. Food waste amount, type and origin in Finland. Date of retrieval 20.11.2020. https://helda.helsinki.fi/bitstream/handle/10138/318224/Food-Wast.pdf?sequence=1&isAllowed=y

6. Yle. 2015. Finnish residents throw out 24 kilos of edible food each year. Date of retrieval 16.10.2020. https://yle.fi/uutiset/osasto/news/finnish_residents_throw_out_24_kilos_of_edible_food_each_year/8302696

7. European Commission. 2020. “Best before” and “Use by” dates on food packaging understand them right to prevent food waste and save money. Date of retrieval 16.10.2020. https://ec.europa.eu/food/sites/food/files/safety/docs/fw_lib_best_before_en.pdf

8. Pirhonen, P. 2018. Tackling poverty and waste, new Helsinki supermarket offers surplus food at discount prices. Date of retrieval 16.10.2020. https://newsnowfinland.fi/news-now-original/tackling-poverty-and-waste-new-helsinki-supermarket-offers-surplus-food-at-discount-prices#:~:text=Finland's%20grocery%20store%20waste%20problem,problem%20with%20the%20whole%20process.

9. Katajajuuri, J.-M. 2014. Food waste in the Finnish food chain, Journal of Cleaner Production 73 (3), 322-329. Date of retrieval 20.11.2020 https://www.sciencedirect.com/science/article/pii/S0959652613009116.

10. Ohemeng, M. 2019. A measure of the problem of food waste in grocery shops, Tampere, Finland. Date of retrieval 30.11.2020 https://www.theseus.fi/bitstream/handle/10024/266531/Ohemeng%2c%20Mark.pdf?sequence=4&isAllowed=y

11. Natural Resources Institute Finland. 2020. Food waste and the circular economy of the food system. Date of retrieval 27.11.2020 https://www.luke.fi/en/natural-resources/food-and-nutrition/food-waste-and-the-circular-economy-of-the-food-system/#:~:text=In%20Finland%2C%20households%20waste%20120,kilograms%20per%20person%2C%20every%20year.&text=The%20climatic%20effects%20of%20unnecessary,1%2C000%20million%20kilograms%20CO2%20equivalent.

12. WRAP. 2017. Getting more value from food and drink by-products and wastes. Date of retrieval 27.11.2020 http://www.refreshcoe.eu/wp-content/uploads/2017/06/Getting-more-value-mapping-tool.pdf

13. Haaramo, E. 2016. Finnish startups turn food waste into great taste. Date of retrieval 2.12.2020 https://www.goodnewsfinland.com/feature/finnish-startups-turn-food-waste-into-great-taste/

14. From Waste To Taste ry. 2020. Introduction to Waste To Taste. Date of retrieval 2.12.2020 http://waste2taste.com/in-english/

15. SYKE. 2019. WeFood: Finland’s first surplus food store. Date of retrieval 4.12.2020 https://www.energialoikka.fi/en/wefood-food-waste-store/

16. WeFood. 2020. Welcome to WeFood, Finland’s first ever supermarket selling surplus food. Date of retrieval 4.12.2020 https://wefood.fi/finn-church-aid-opens-finlands-first-ever-supermarket-selling-surplus-food/

17. MongoDB, Inc. 2020. MERN Stack. Date of retrieval 13.12.2020 https://www.mongodb.com/mern-stack

18. Microsoft. 2020. TypeScript Documentation. Date of retrieval 07.12.2020 https://www.typescriptlang.org/docs/

19. Rascia, T. 2018. React Tutorial: An overview and walkthrough. Date of retrieval 07.12.2020 https://www.taniarascia.com/getting-started-with-react/

20. Facebook, Inc. 2020. React Docs: Getting started. Date of retrieval: 07.12.2020 https://reactjs.org/docs/getting-started.html

21. Bachuk, A. 2016. Redux – An introduction. Date of retrieval 09.12.2020 https://www.smashingmagazine.com/2016/06/an-introduction-to-redux/

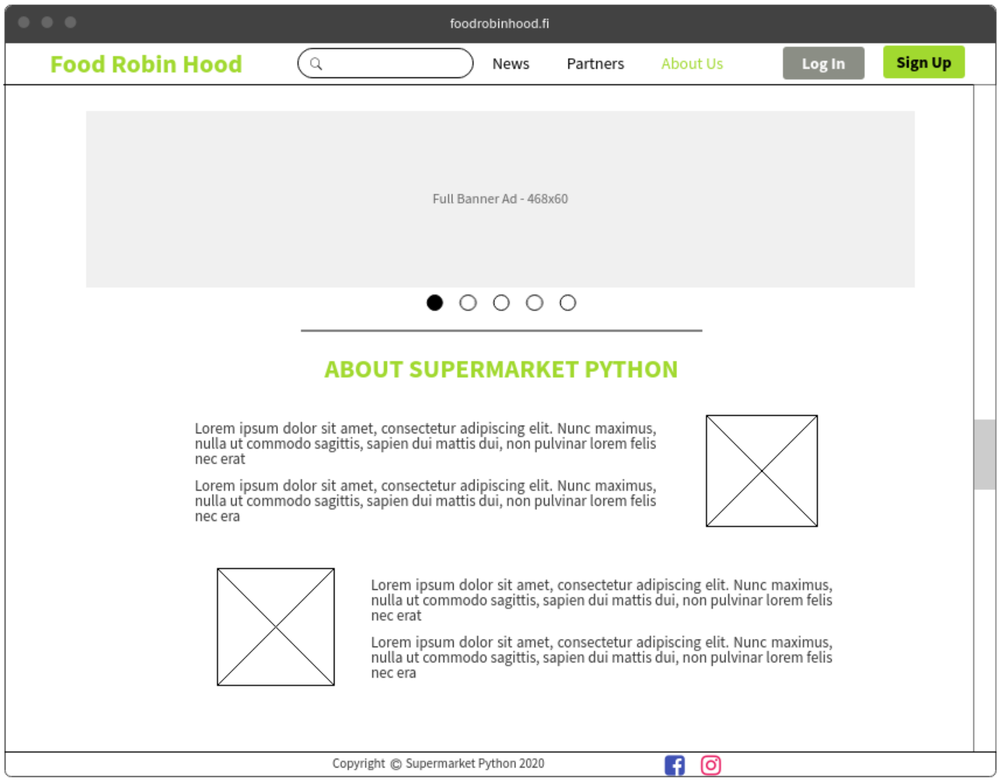
22. Abramov D., the Redux documentation authors. 2020a. Getting started with Redux. Date of retrieval 09.12.2020 https://redux.js.org/introduction/getting-started

23. Abramov D., the Redux documentation authors. 2020b. What is Redux Toolkit? Date of retrieval 09.12.2020 https://redux.js.org/redux-toolkit/overview

24. Joyent, Inc. 2020. Introduction to Node.js. Date of retrieval 09.12.2020 https://nodejs.dev/learn/introduction-to-nodejs

25. EDUCBA. 2020. What is ExpressJS? Date of retrieval 09.12.2020 https://www.educba.com/what-is-expressjs/

26. Saini, A. 2020. What is MongoDB - Working and features. Date of retrieval 09.12.2020 https://www.geeksforgeeks.org/what-is-mongodb-working-and-features/



ABOUT SUPERMARKET PYTHON

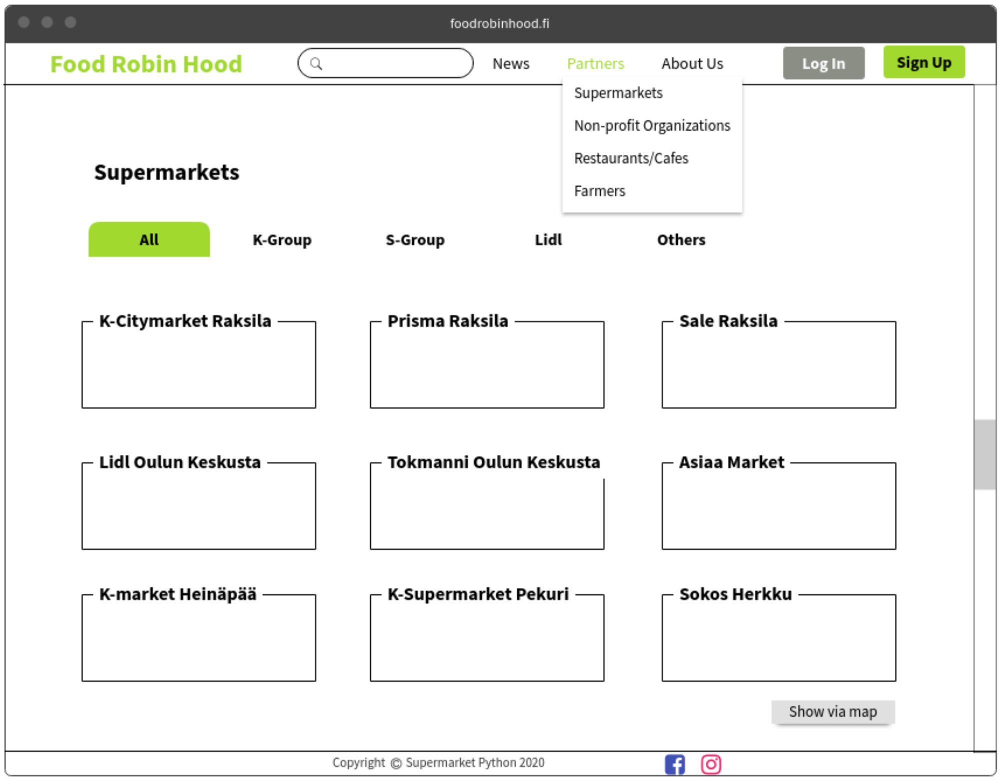
Lorem ipsum dolor sit amet, consectetur adipiscing elit. Nunc maximus, nulla ut commodo sagittis, sapien dui mattis dui, non pulvinar lorem felis nec erat

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Nunc maximus, nulla ut commodo sagittis, sapien dui mattis dui, non pulvinar lorem felis nec era

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Nunc maximus, nulla ut commodo sagittis, sapien dui mattis dui, non pulvinar lorem felis nec erat

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Nunc maximus, nulla ut commodo sagittis, sapien dui mattis dui, non pulvinar lorem felis nec era

Copyright © Supermarket Python 2020



Supermarkets

K-Citymarket Raksila

Prisma Raksila

Sale Raksila

Lidl Oulun Keskusta

Tokmanni Oulun Keskusta

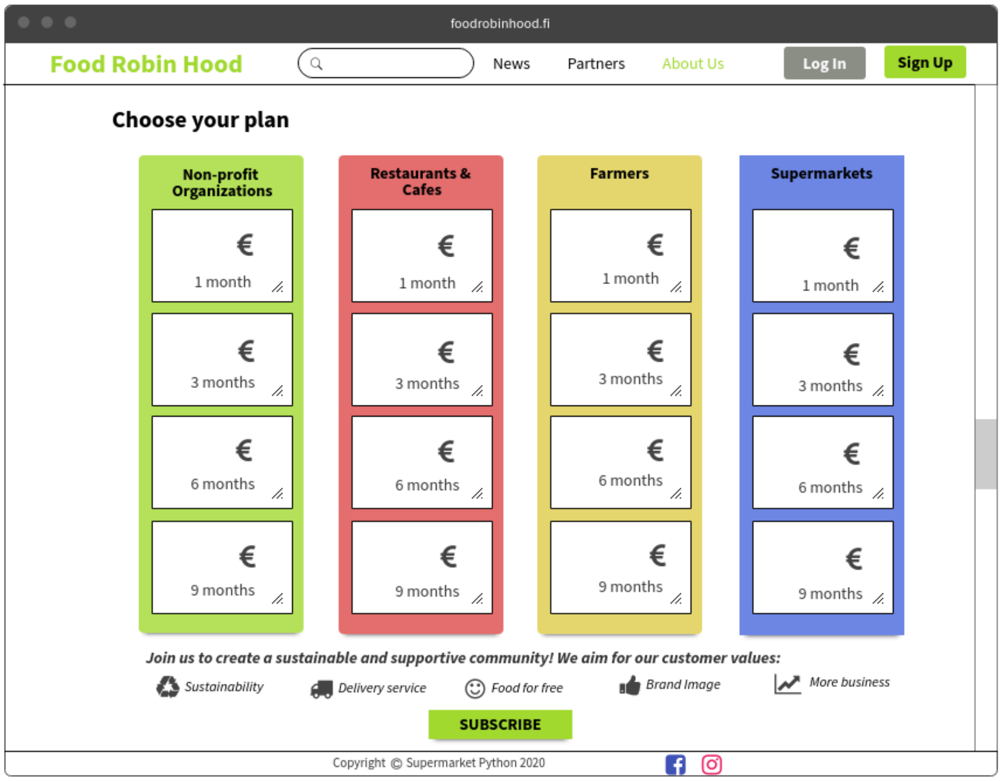
Asiaa Market

K-market Heinäpää

K-Supermarket Pekuri

Sokos Herkku

Copyright © Supermarket Python 2020



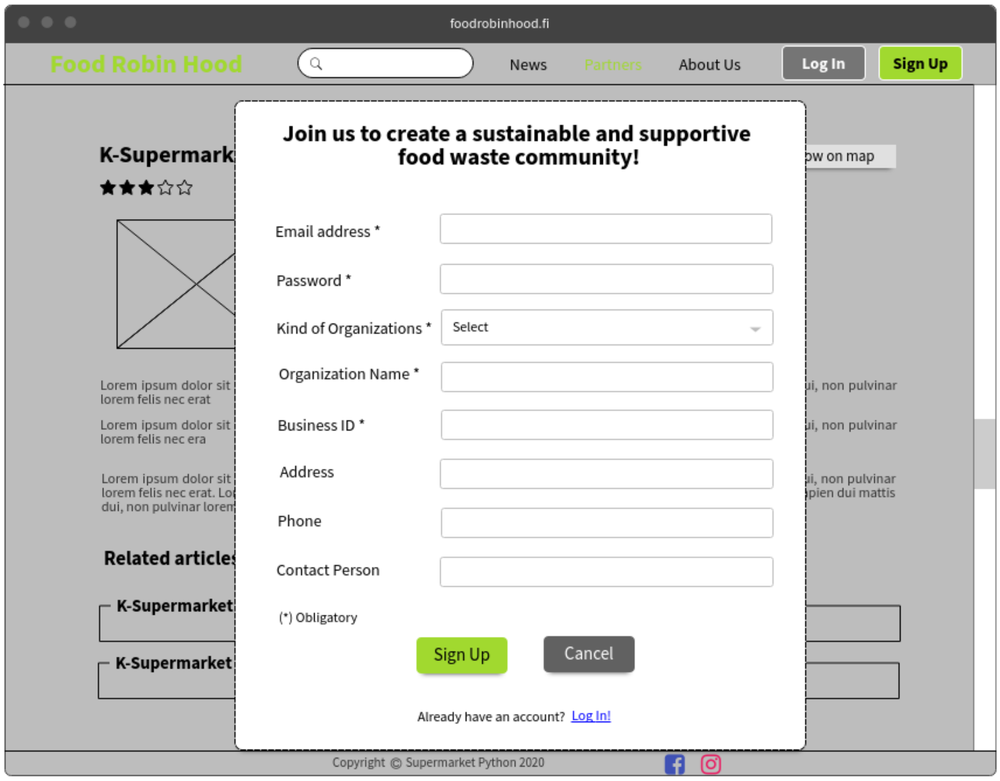
Choose your plan

Non-profit Organizations	Restaurants & Cafes	Farmers	Supermarkets
€ 1 month	€ 1 month	€ 1 month	€ 1 month
€ 3 months	€ 3 months	€ 3 months	€ 3 months
€ 6 months	€ 6 months	€ 6 months	€ 6 months
€ 9 months	€ 9 months	€ 9 months	€ 9 months

Join us to create a sustainable and supportive community! We aim for our customer values:

Sustainability *Delivery service* *Food for free* *Brand Image* *More business*

Copyright © Supermarket Python 2020



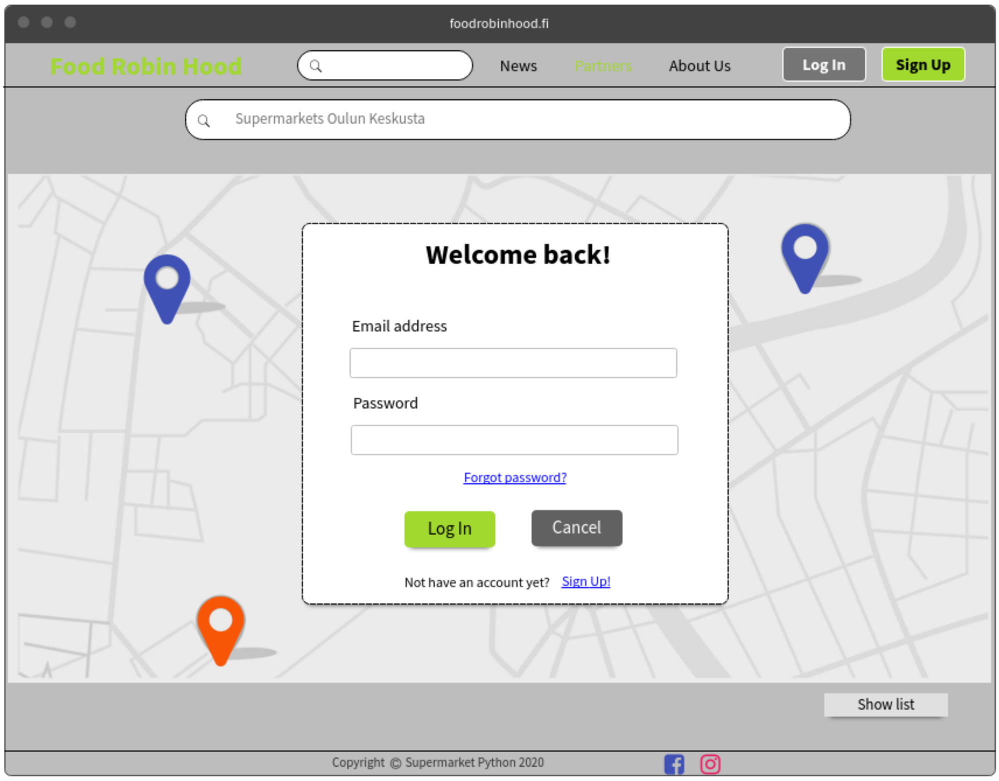
Join us to create a sustainable and supportive food waste community!

Email address *	
Password *	
Kind of Organizations *	Select
Organization Name *	
Business ID *	
Address	
Phone	
Contact Person	

(*) Obligatory

Already have an account? Log In!

Copyright © Supermarket Python 2020



Welcome back!

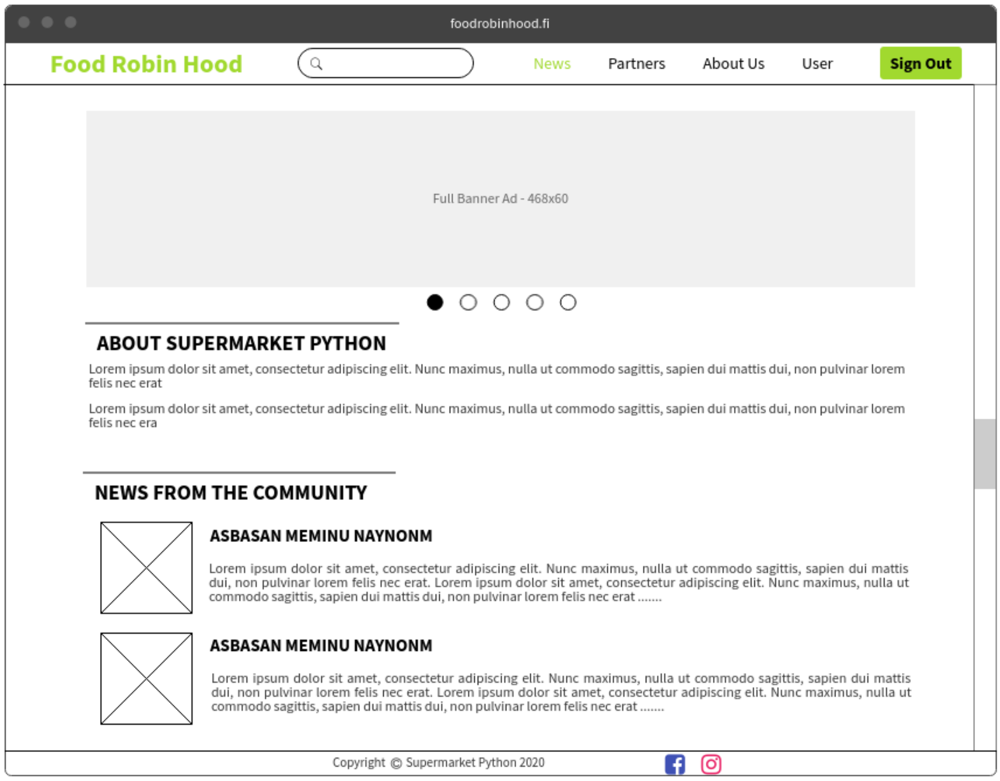
Email address

Password

Forgot password?

Log In Cancel

Not have an account yet? Sign Up!



ABOUT SUPERMARKET PYTHON

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Nunc maximus, nulla ut commodo sagittis, sapien dui mattis dui, non pulvinar lorem felis nec erat

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Nunc maximus, nulla ut commodo sagittis, sapien dui mattis dui, non pulvinar lorem felis nec era

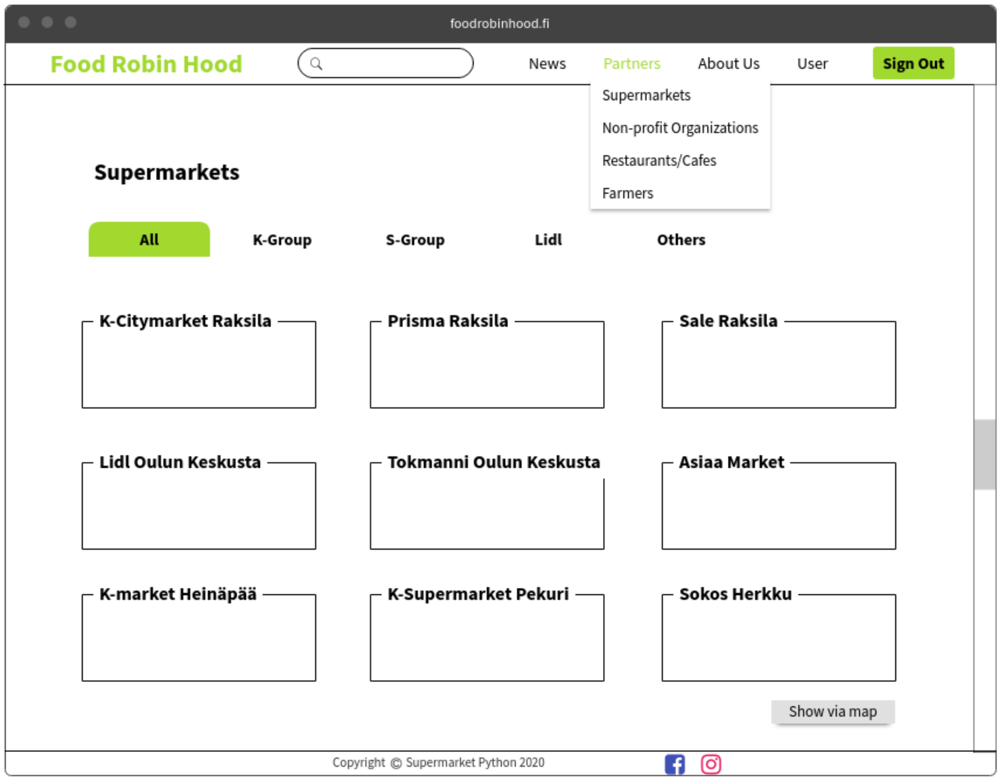
NEWS FROM THE COMMUNITY

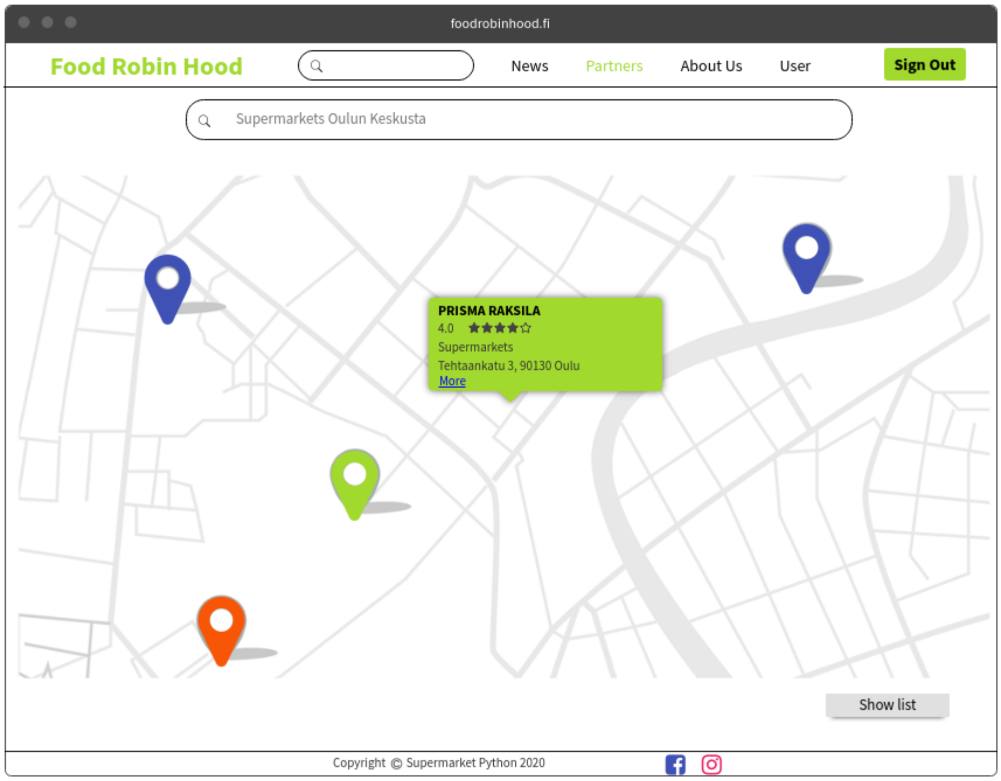
ASBASAN MEMINU NAYNONM

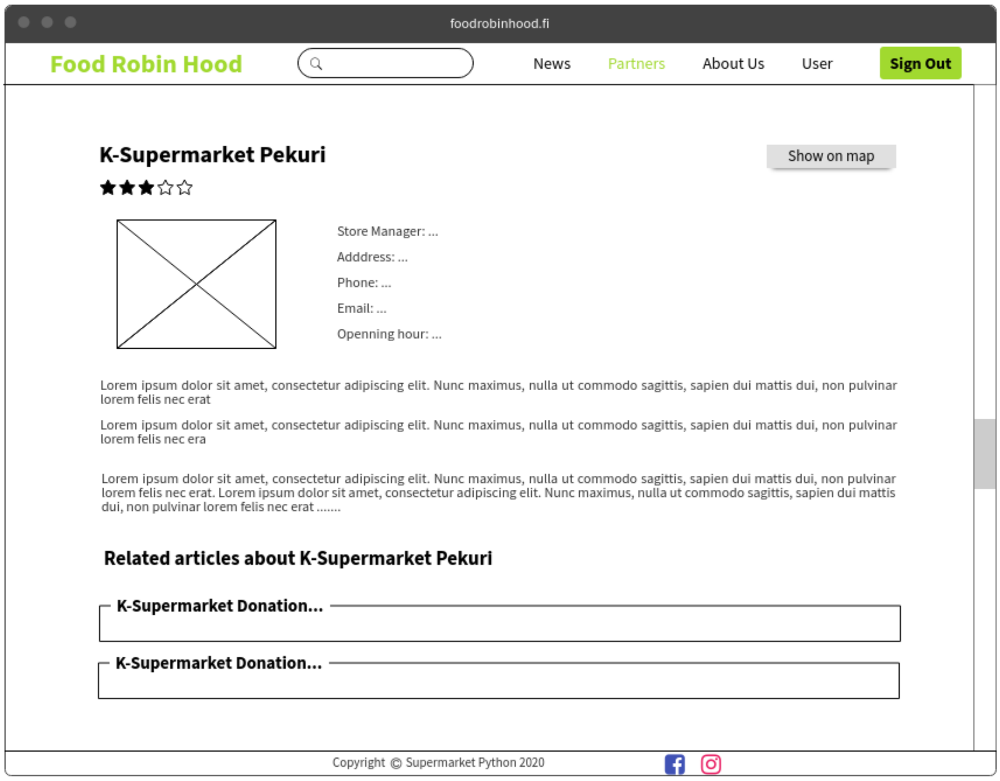
Lorem ipsum dolor sit amet, consectetur adipiscing elit. Nunc maximus, nulla ut commodo sagittis, sapien dui mattis dui, non pulvinar lorem felis nec erat. Lorem ipsum dolor sit amet, consectetur adipiscing elit. Nunc maximus, nulla ut commodo sagittis, sapien dui mattis dui, non pulvinar lorem felis nec erat ....

ASBASAN MEMINU NAYNONM

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Nunc maximus, nulla ut commodo sagittis, sapien dui mattis dui, non pulvinar lorem felis nec erat. Lorem ipsum dolor sit amet, consectetur adipiscing elit. Nunc maximus, nulla ut commodo sagittis, sapien dui mattis dui, non pulvinar lorem felis nec erat ....


foodrobinhood.fi
Food Robin Hood
News
Partners
About Us
User
Sign Out
Supermarkets
Non-profit Organizations
Restaurants/Cafes
Farmers
Supermarkets
All
K-Group
S-Group
Lidl
Others
K-Citymarket Raksila
Prisma Raksila
Sale Raksila
Lidl Oulun Keskusta
Tokmanni Oulun Keskusta
Asiaa Market
K-market Heinäpää
K-Supermarket Pekuri
Sokos Herkku
Show via map
Copyright © Supermarket Python 2020


foodrobinhood.fi
Food Robin Hood
News
Partners
About Us
User
Sign Out
Supermarkets Oulun Keskusta
PRISMA RAKSILA
4.0 ★★★★☆
Supermarkets
Tehtaankatu 3, 90130 Oulu
More
Show list
Copyright © Supermarket Python 2020



K-Supermarket Pekuri

★★★☆☆

Store Manager: ...

Adddress: ...

Phone: ...

Email: ...

Openning hour: ...

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Nunc maximus, nulla ut commodo sagittis, sapien dui mattis dui, non pulvinar lorem felis nec erat

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Nunc maximus, nulla ut commodo sagittis, sapien dui mattis dui, non pulvinar lorem felis nec era

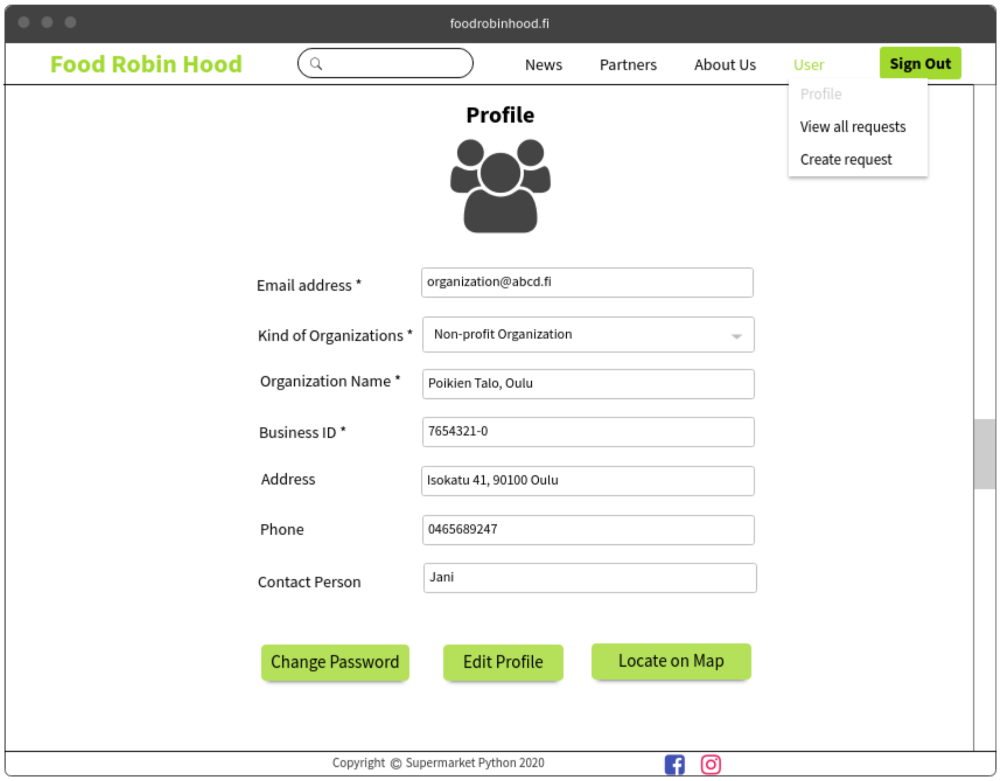
Lorem ipsum dolor sit amet, consectetur adipiscing elit. Nunc maximus, nulla ut commodo sagittis, sapien dui mattis dui, non pulvinar lorem felis nec erat. Lorem ipsum dolor sit amet, consectetur adipiscing elit. Nunc maximus, nulla ut commodo sagittis, sapien dui mattis dui, non pulvinar lorem felis nec erat ....

Related articles about K-Supermarket Pekuri

K-Supermarket Donation...

K-Supermarket Donation...

Copyright © Supermarket Python 2020



Profile

Email address * organization@abcd.fi

Kind of Organizations * Non-profit Organization

Organization Name * Poikien Talo, Oulu

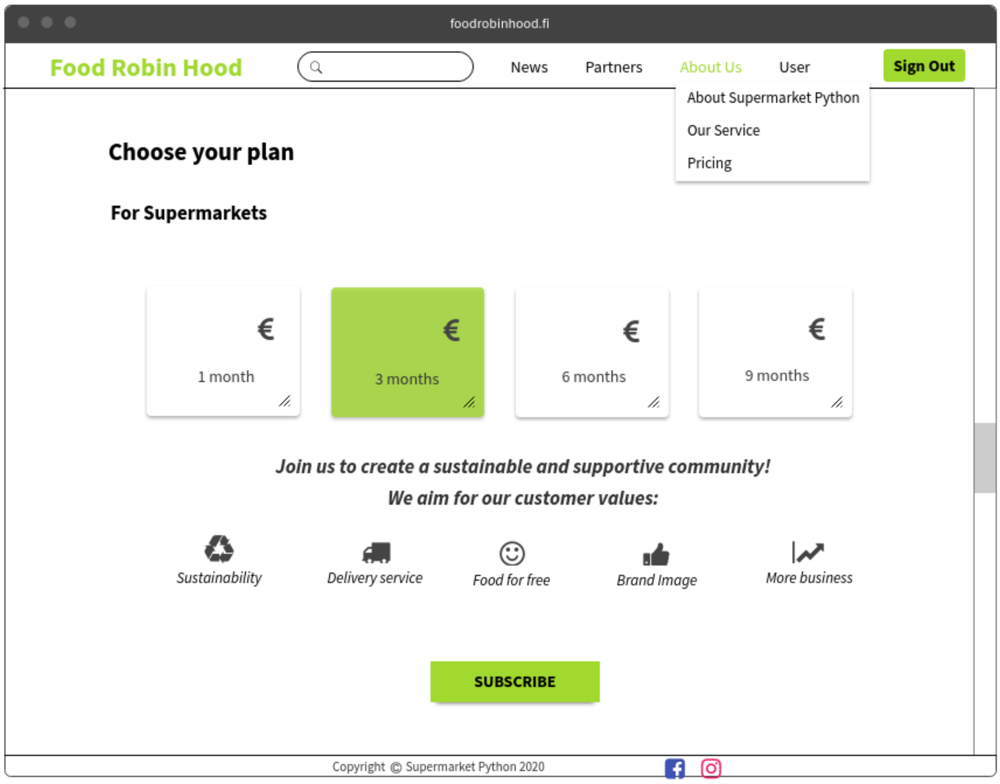
Business ID * 7654321-0

Address Isokatu 41, 90100 Oulu

Phone 0465689247

Contact Person Jani

Copyright © Supermarket Python 2020

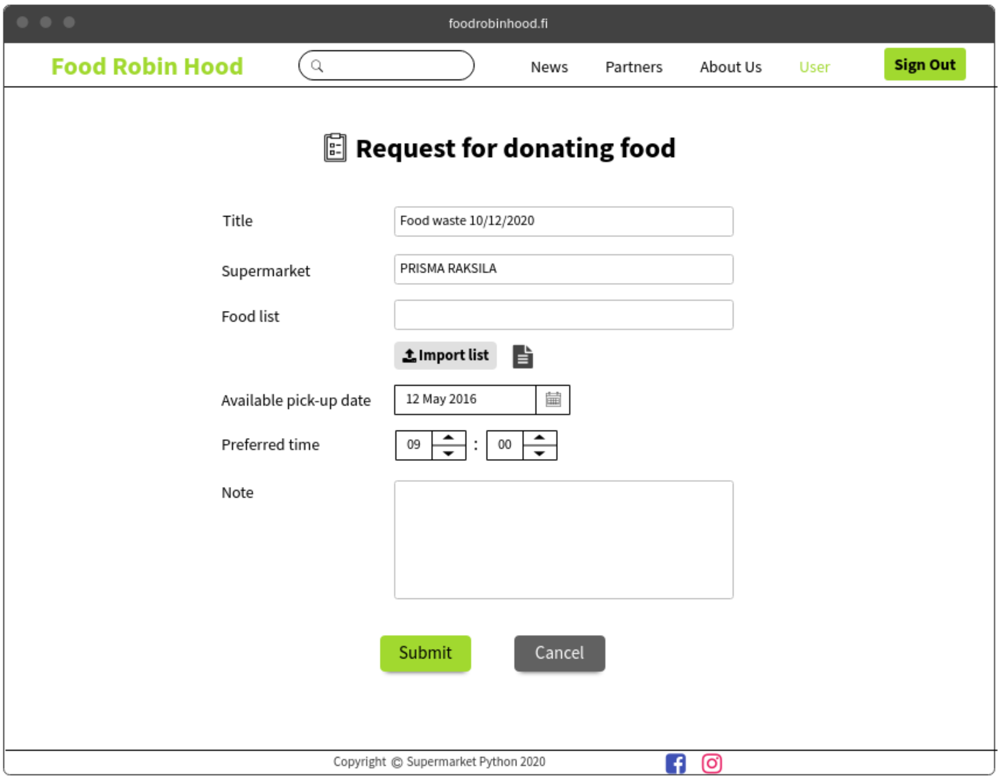


Choose your plan

For Supermarkets

Join us to create a sustainable and supportive community!

We aim for our customer values:



Request for donating food

Title: Food waste 10/12/2020

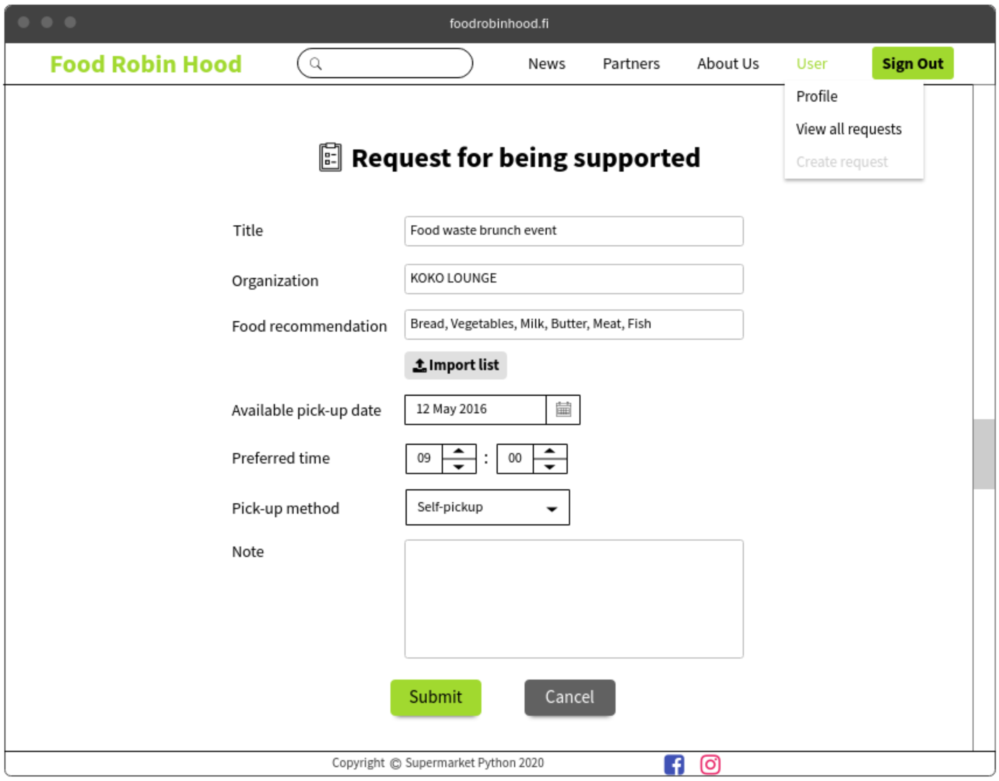
Supermarket: PRISMA RAKSILA

Food list:

Available pick-up date: 12 May 2016

Preferred time: 09 : 00

Note:



Request for being supported

Title: Food waste brunch event

Organization: KOKO LOUNGE

Food recommendation: Bread, Vegetables, Milk, Butter, Meat, Fish

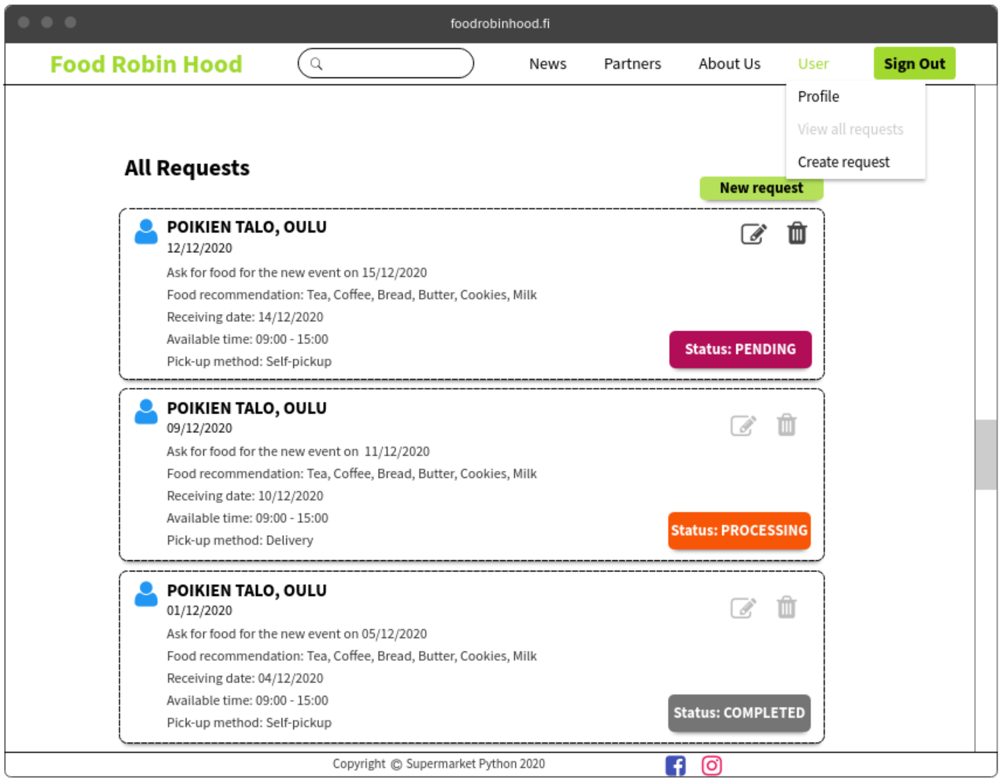
Available pick-up date: 12 May 2016

Preferred time: 09 : 00

Pick-up method: Self-pickup

Note

Copyright © Supermarket Python 2020



All Requests

POIKIEN TALO, OULU
12/12/2020
Ask for food for the new event on 15/12/2020
Food recommendation: Tea, Coffee, Bread, Butter, Cookies, Milk
Receiving date: 14/12/2020
Available time: 09:00 - 15:00
Pick-up method: Self-pickup
Status: PENDING

POIKIEN TALO, OULU
09/12/2020
Ask for food for the new event on 11/12/2020
Food recommendation: Tea, Coffee, Bread, Butter, Cookies, Milk
Receiving date: 10/12/2020
Available time: 09:00 - 15:00
Pick-up method: Delivery
Status: PROCESSING

POIKIEN TALO, OULU
01/12/2020
Ask for food for the new event on 05/12/2020
Food recommendation: Tea, Coffee, Bread, Butter, Cookies, Milk
Receiving date: 04/12/2020
Available time: 09:00 - 15:00
Pick-up method: Self-pickup
Status: COMPLETED

Copyright © Supermarket Python 2020