MEAT et AL

TECHNICAL DOCUMENTATION

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Abstract

The livestock sector has grown into being the main Climate Change driver of the century and therefore, the world's main target according to organizations such as the United Nations. This is caused by the unsustainable amount of natural resources required for farming and agriculture such as global water consumption, massive land use, and final greenhouse gas emissions. Growing technologies such as food recommender systems are being developed in the pursuit of sustainable product consumption, and are seen as an efficient tool for raising awareness on topics like sustainability. These food recommender systems have proven to generate a positive impact on consumers, especially young consumers, by adapting to their context and preferences. This study will explore how a food recommender system can help young adults reduce the consumption of their animal-based products and make them sustainably aware of the environmental impacts of their consumption. A problem definition and user study will be carried out using Design Thinking tools such as questionnaires and interviews with both consumers and experts to gain a deep understanding of the problem. Finally, the proposed prototype will be tested according to its structure, look&feel, and implementation and will be tested for the concept, usability, and final A/B testing to prove theory and functionality. As a result of this study, the first foundations are laid to achieve a data-driven application that will help users to make purchasing decisions that benefit both themselves and the environment as they continue their journey to reduce their consumption of animal-based products.

Project Overview

Introduction

To survive a climate change wave 2.5 million years ago, our bodies evolved to be capable of eating meat, and we adopted it as part of our diet, culture, or religion (Bassett, 2020). This demand for animal-based products (ABPs) has triplicated numbers in the last 50 years due to the evolution of production technologies and population growth thus, generating a high risk of running out of natural resources to feed the whole population due to the massive waste on water consumption, the pollution of land usage, and the the emission of greenhouse Gasses (GHGs) required for faming, agriculture, and production (Ritchie & Roser, 2019). On the other hand, technologies such as Food Recommender Systems (FRSs) have proven to be have proven to be good allies in encouraging healthy consumption by raising consumer awareness through their focus on the context of their users to generate recommendations (Elsweiler & Trattner, 2017).

Therefore, this final prototype aims to develop a FRSs, together with tools such as Figma or Python, which, in order to promote sustainable awareness and ultimately reduce their consumption of ABPs, will propose alternatives to its users. Through this case study, we will see the evolution of these prototypes using the Design Thinking methodology.

Problem Space

The livestock sector has become the main accelerator of climate change in the 21st century according to the UN Environment Programme (2018). Due to the continued need for natural resources such as land, water, and energy fuel, we are causing the emission of harmful greenhouse gasses (GHGs), the destruction of our rainforest for agriculture and crops, and the pollution of clear water for animals and irrigation. (Djekic, 2015). This demand has tripled in the last 50 years (OECD and Food and Agriculture Organization of the United Nations, 2021) thanks to the evolution of production technologies, the effect of population growth, and a rise in the western social economy (Sanchez-Sabate & Sabaté, 2019). In countries such as the United States, Australia, and Argentina, ABPs consumption is increasing every year by 100 kg of meat consumed per person (The World Counts, 2021). To satisfy this demand, the production makes use of about 80% of the Earth's terrestrial fields for agriculture and cultivation, and up to 70% of the world's clear waters, according to Our World in Data (Ritchie, 2017). The continued growth of these practices has led to deforestation, a threat to biodiversity, induced a global monetary impact (Springmann, 2018), and crucially, emissions of 14.5% of all human-generated GHGs (United Nations Food and Agriculture, 2018) making it the leading cause of global climate change in the 21st century .

Target Audience

As one of Europe's leading exporters of animal products, the Netherlands is experiencing a climate change crisis due to high levels of nitrogen (N) from its livestock farms (OECD Economic Surveys: Netherlands, 2021). These alterations in the environment, together with concerns in public health such as the prevention of cancer, have been the principal causes of food consumption changes in the country (Weinrich, 2019). Different studies have proven that the Dutch community has begun to consume more meat substitutes as opposed to other eastern European countries (Weinrich, 2019; Kemper & White, 2021). However, Weinrich (2019) also concluded that information on food alternatives remains an obstacle to encouraging certain consumers.

The consumption of ABPs have both biophysical and biocultural factors that alter the way we consume and the choices we make around it (van Vliet et al, 2020). To date, several studies have examined the links between ABP consumption and personas. For instance, a German study investigated the correlations between ABP consumers and their personality traits and found that ABP consumption is particularly related to older, politically conservative male participants with lower education as opposed to younger, higher educated females (Pfeiler & Egloff, 2019). Even though sex was the least correlated variable, age and ideology seemed to play a bigger role in the way participants took care of their health and the environment. For these reasons, this study will focus the target group on young adults located in the Netherlands.

Exploring solutions

Governmental agreements such as the Paris Climate Agreement (PCA) of 2015 were conceived by the United Nations to fight climate change with the ambition to reduce the global mean temperature by 1.5ºC (DeConto et al, 2021). Despite the increasing implementation of strategies and technologies by the livestock sector, such as the provision of fat additives to ruminants to reduce methane (CH4) or the conversion of abandoned land into forests (afforestation) to achieve zero CO2 targets (Ridoutt, 2021), it is not yet known whether these new technologies alone can mitigate these GHGs emissions in the future (Hedenus, 2014). New advances in food production are ready to provide new perspectives on the way humans consume ABP. For example, the use of three-dimensional printing (3DP) allows the creation of personalized foods both vegetables and fake meat for each person or situation, favoring nutrition, avoiding the use of animal flesh, reducing the carbon footprint, and even a possible future solution to world hunger (Dick, Bhandari, Prakash, 2019). Unfortunately, access to these technologies is still limited to investigations and food production companies and not to the daily consumer.

Since they arrived in the 1990s, recommender systems (RSs) have facilitated users' online access to products from clothes to cars in an ordered and individualized way (Konstan & Riedl, 2012). RSs predict the probability of a product being selected by a certain consumer (Zhang et al., 2019, Ricci et al., 2011). In the case of food, users make decisions about it on a daily and contextual basis (Elsweiler, Hauptmann, & Trattner, 2012), giving RS great power to influence these decisions (Viniski et al, 2021). FRSs have proven to be a key solution for healthy choices by raising health awareness among users favoring certain products' consumption over others (Elsweiler & Trattner, 2017; Freyne, Berkovsky & Smith, 2011). Thanks to implementations such as content-based filtering (CBF) or context-aware filtering (CA) (Elahi et al, 2015), recommendations can be even more personalized by better identification of the user's likes, product ratings, and/or the link to health-conscious statistics (Elsweiler & Trattner, 2017).

The prototype developed following this research ultimately aims to mitigate the environmental impact of the livestock sector by recommending sustainable alternatives on users' shopping lists that will lead them to reduce their ABP consumption.

Research Question

For these reasons the research question is as follows:

How can a Food Recommender System help young adults reduce their animal-based product consumption and make them more aware of the environmental impacts of ABP production?

The process

Data Collection, Survey

The survey will consist of 12 multiple-choice questions representing the quantitative data, and 6 short questions for qualitative data from 22 participants (Appendix B, survey 1). This method was selected due to the quick and efficient way of reaching multiple users in a shorter time and therefore, obtaining a good number of responses to validate the research question (RQ).

Goal

With a total of 22 responses (N=22) from the target audience selected, this questionnaire not only helps deeper understanding the context of our users around the consumption of ABPs and their daily consumption habits, but it also lays the foundations for our final target persona (Blomkvist, 2002).

Insights

This first questionnaire aims to answer questions such as which supermarket do you normally go to, what are the reasons for your consumption of ABPs, have you tried to reduce your consumption of ABPs, how aware are you of the impact of ABP consumption and production and why. Following the responses, the most interesting insights collected were:

- 65% of participants have considered reducing their consumption of ABPs at some point.
- The two main reasons were environmental, moral and ethical (Figure 1).
- The two reasons for not keeping it up were health and liking ABPs too much (taste).
- 60% consider themselves aware of the impacts on the environment.

However:

- The most selected diet among the participants was *Omnivore* with 50%, with *Meat Eater* second with 23% (Figure 2).
- The average consumption of ABPs is between '*More than twice a week*' (36.5%) and '*At least once a day*' (32%).

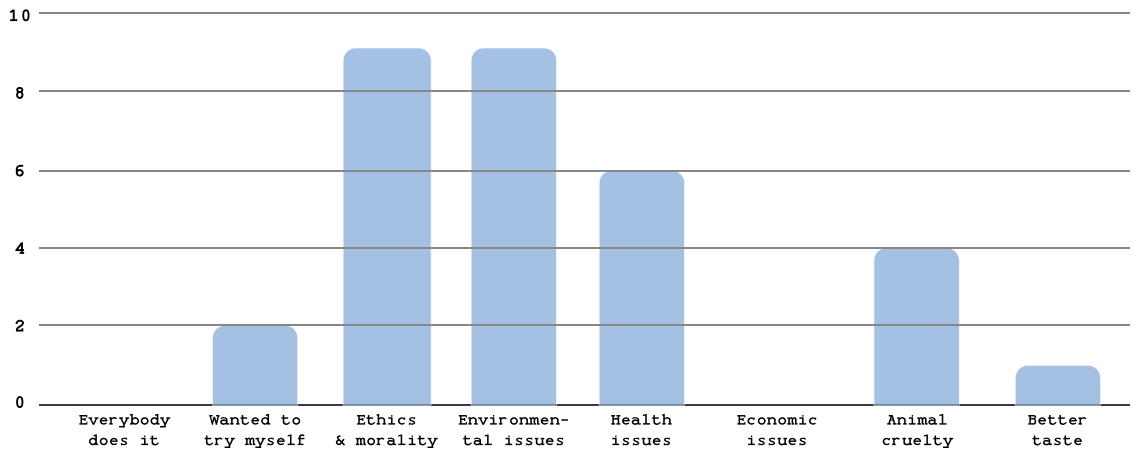


Figure 1. Reasons to consider reduce ABPs.

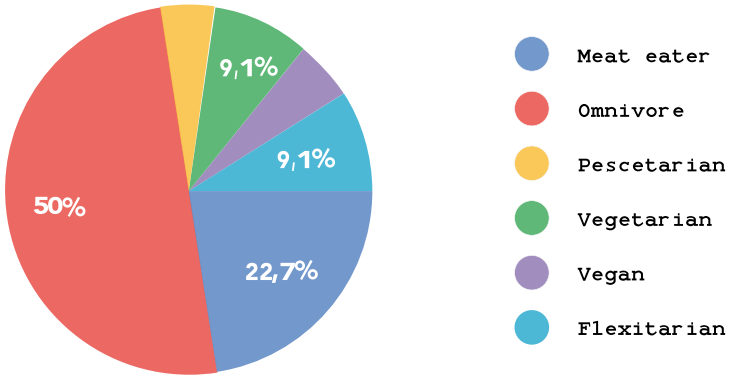


Figure 2. Types of diet followed by our participants.

Finally, when asked if they would like to know more about the issue in order to raise awareness:

- 9 participants have answered *Yes* and added that they would also like to know how to improve it and how to make a better consumption.
- 7 participants simply said *No*.
- 3 participants said *No* because they are already aware of what is happening.
- 1 participant simply answered: *I feel like we all know a lot about the topic, so I do not understand what people are against vegetarians/vegans. This is my main interest right now.*

Goal

This questionnaire confirmed that among this focus group there is the dilemma that Mazirow's (Salehi, Carmona, Redondo, 2020) talks about in the new types of diets that are beginning to emerge, valuing changes in their consumption habits, and wanting to know more in order to do it in an efficient way. This was also seen and given during the user interviews.

Expert Interviews

Three expert interviews were conducted during this research. Firstly, the research required not only a theoretical part but also an understanding of what was really happening, how it was affecting the livestock sector in this case in the Netherlands, how it was being experienced, what solutions were being considered and even what was going wrong. In order to answer these questions, a farmer entrepreneur and engineer was contacted and he was the one who answered these questions. Secondly, both the contextualisation of the problem and the prototype required help in the field of food to ensure that the final prototype does not put its users at risk, and from the knowledge of the supermarkets themselves, product selection, and users' consumption.

Insights

Farmer engineer's main insights:

- This new wave of reducing ABPs is gonna affect families, cultures, business, and communities.
- Bio products are gonna continue suffering due to the natural dependences.
- The need for more and more precise research from the government. More Data-Driven solutions.
- The lack of credible and efficient research leads to lack of awareness among workers, providers, and consumers.

AH Team Lead and environment expert's main insights:

- AH is incoorporating more and more PBPs to their offer due to the new demand and making them more affordable.
- There is a new customer consumption especially among young people. Elderly is more hesitant to the shift.
- This need of awareness is a marketing strategy. They don't dedicate the time to it, it's only profit. This prototype could help with that.
- The new dutch regulations will also aftect their offer and demand so AH is slowly adapting its image and products to it.

Nutritionist's main insights:

- New plant-based diet contribute not only to a better environmental impact but also to the health of consumers.
- Many big companies are using ABPs and PBPs as profit so there is a lot of misconception and misinformation about diets.
- This solution could help also nutritionists to bring these diets closer by supporting better consumption.
- However, there are also risks on how this prototype approaches the problem due to the lack of certain nutrients and vitamines on PBPs.

Crafting persona & Customer Journey

After better understanding the concerns, needs, wants, and desires of the study group, a persona or archetype (Image 1) was developed to represent that group throughout the design process and define its goals (Blomkvist, 2002). This persona will assist in ideation along with the Customer Journey (Image 2) to define the possible features and interactions of the final prototype (Tueanrat, Papagiannidis & Alamanos, 2021).

Persona

- **As a concerned young consumer** , I want to reduce the amount of ABPs I consume.
- **Because**, I am worried of the environmental consequences it carries and my own well-being.
- **But/And**, I know there are some steps I can take to manage it but I'm lacking the knowledge and means to achieve it.

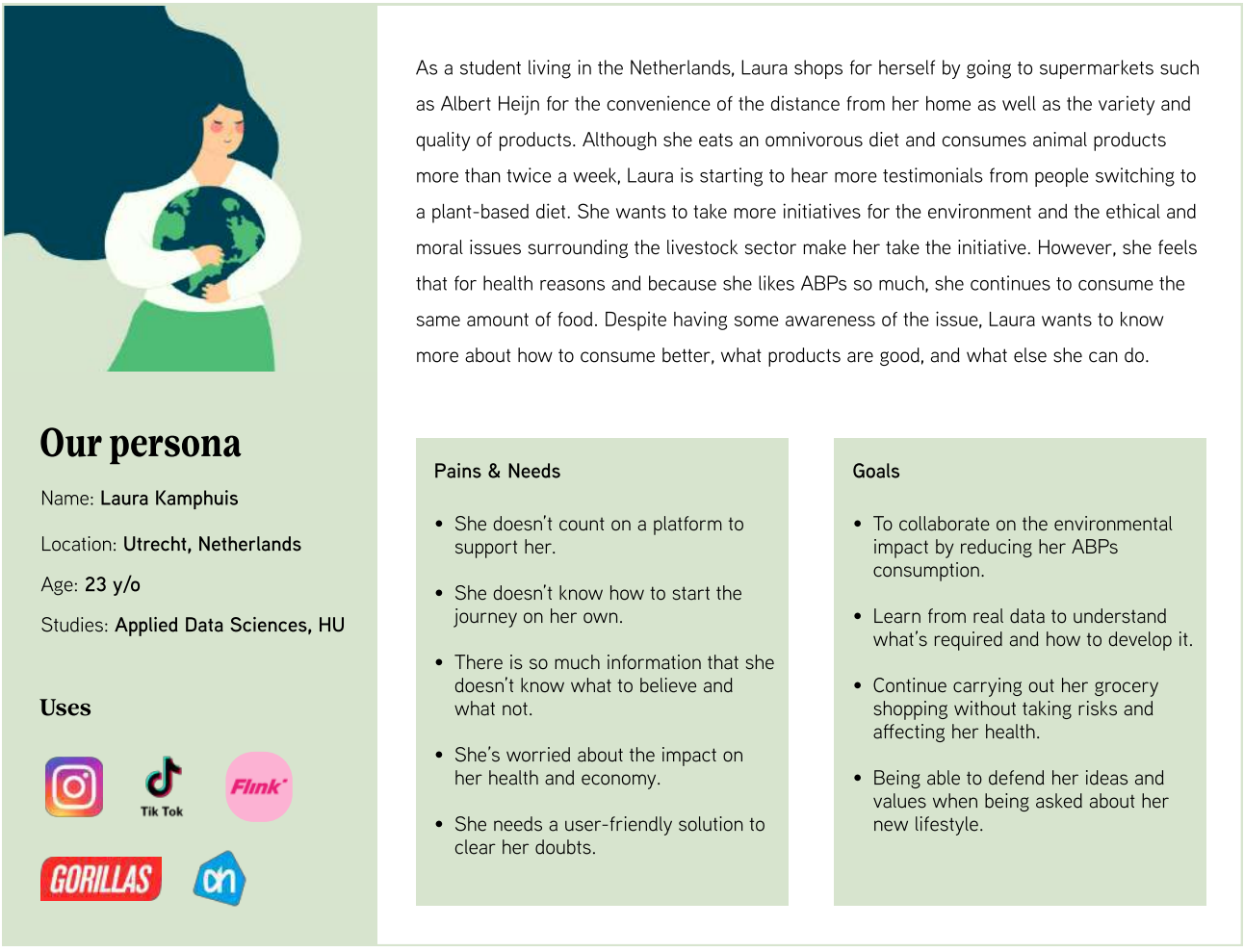


Image 1. Persona.

Customer Journey

In order to design optimal user experiences, large companies such as Amazon or Google make use of this tool to understand a user's journey through their services or products both online and offline (Lemon & Verhoef, 2016). In this prototype, we intend to implement the steps of Mezirow's Transformative Learning Theory (TLT), which several studies on consumption and awareness have defined as suitable for bringing the livestock sector problem closer to users and reducing their meat consumption (McDonald, 2000; Beardsworth & Keil, 1991; Salehi, Carmona, Redondo, 2020). These steps are summarised as dilemma, awareness, attitude and action, and according to Mezirow's (1997), the application of this methodology will lead the user to a process of critical reflection and exploration. Therefore, as depicted in the image below, through the user experience of the prototype, the user will go through the different steps explained by Mezirow until reaching the final goal which is the reduction of ABPs from their diet.

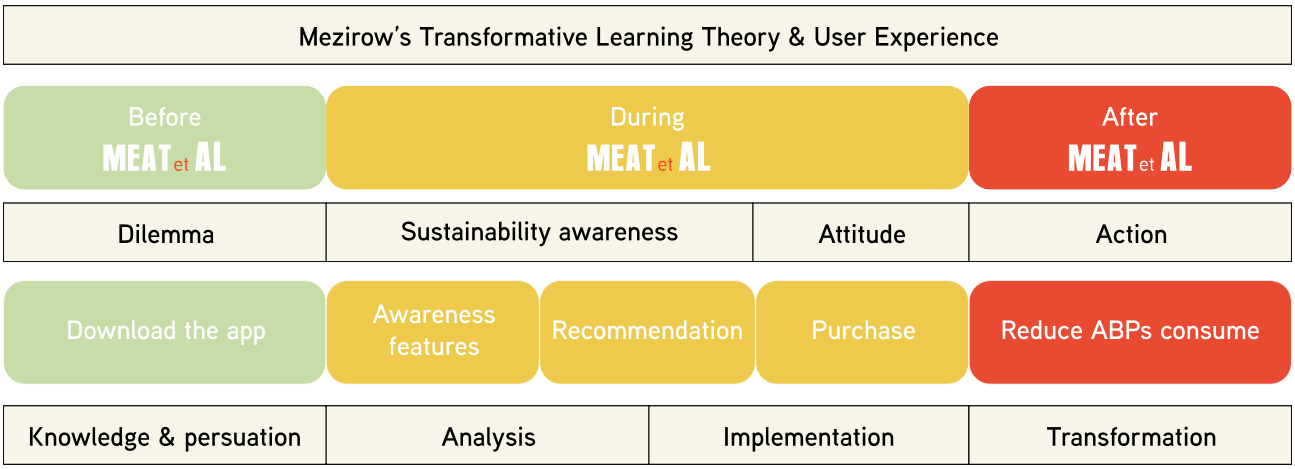


Image 2. Simplified Customer Journey.

Figma Prototype Ideation

Food Recommender systems have proven to be good allies in the quest to raise consumer awareness, for instance, on health and environmental issues, especially through the use of applications. This final prototype will consist of a mobile application that connects users with local supermarkets and generates recommendations based on 1) the user's diet preferences (CA), 2) the interaction of the user with the different products and 3) the characteristics of the products (i.e ingredients, summary, description, and price) (Image 3). The user will continue to be able to do their grocery shopping but with the support of a FRS that will turn their product selection into sustainable alternatives according to their diet preferences i.e Flexitarian, Pescetarian, Vegetarian, Vegan (Salehi et al, 2020).

Following Mezirow's TLT, this prototype will aim to increase the public's awareness of the environmental impact of the meat industry, and their motivation to ultimately reduce their ABP consumption by providing information and resources regarding the different diets and the different impacts of the products. This theory will see its impact on our assumptions and ideologies underpinned by the biophysical and biocultural factors (Brinson, 2021).

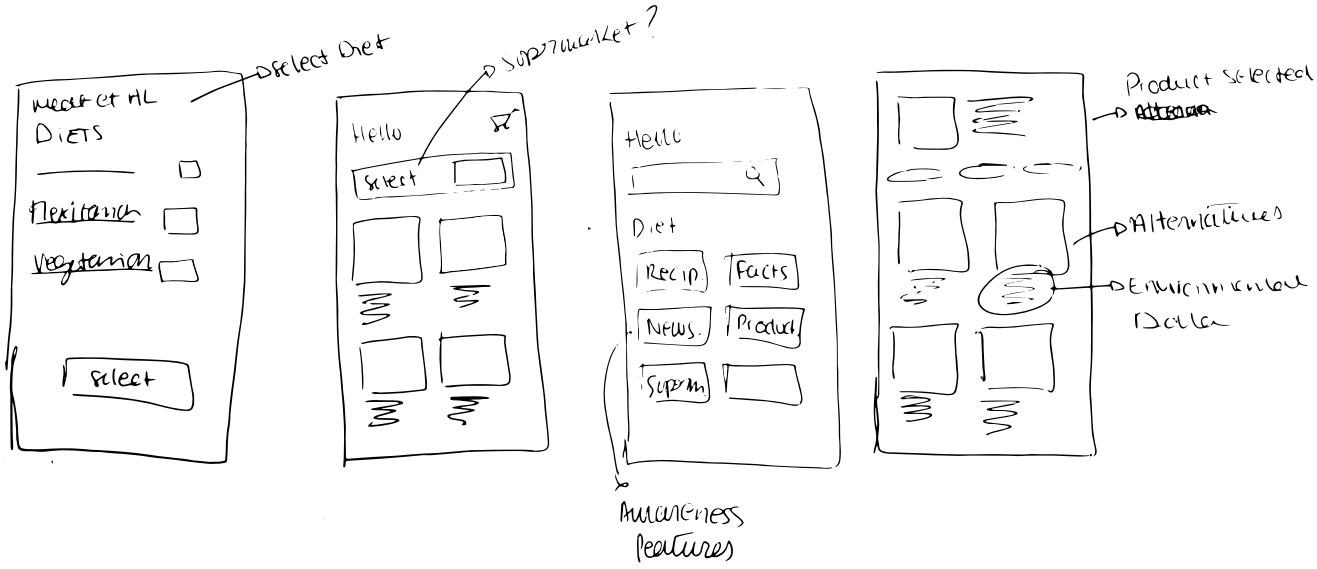


Image 3. First Role Prototype screens.

This prototype is divided into a Look & Feel prototype and an Implementation Prototype. The difference between them is the focus of attention. In a Look & Feel Prototype, we focus on the visual part of the idea without considering the functional part. Through this prototype designed using the Figma tool, we can test the concept and usability by focusing on the navigation through what would be the future app, the accessibility to the different features or the user interaction with the display of the recommendations. Finally, we will see what is missing, what is left over and what needs to be improved. On the other hand, an Implementation Prototype will allow us to develop the functional part of the future app without taking into account the aesthetic part of the app. This prototype will be developed using the Python language and the Jupyter Notebook tool. Through it, we will develop a simple RS based on a CA filtering (in our case, the user's diet preference). The data frame will be composed of products obtained by scraping Albert Heijn's pages. These products have been selected by '*keyword*' (type of food) with the intention of obtaining a wide selection of products by search word and these are: *meat, fish, chicken, nuts, vegetables, fruit, legumes, dairy, cold meat, salad, pastries, cheese, pasta*. On diets, Salehi et al (2020) present the order that consumers follow on their way to reduce consumption of OBA. It starts with *omnivore*, followed by *flexitarian, reducetarian, pescetarian, plant-based, vegetarian* and finally, *vegan*. Within this series, only four diets have been selected because the difference between

certain of these diets differs so little, even between theorists, that from a coding point of view it would take an expert to make such a precise recommendation. For example, according to Kemper & White (2021), a flexitarian is a vegetarian who chooses to include PFAs on certain occasions, and a reducetarian is an omnivore who tries to reduce their intake of PFAs. However, according to Salehi et al (2020), a flexitarian chooses low- or no-meat meals if they have the choice, and a reducetarian reduces their meat intake to once or twice a week. For these reasons, the diets selected for this prototype are Fexitarian, pescetarian, vegetarian, and vegan.

Image 4. Adaptation of Gelareh Salehi et al (2020). It represents the dietary continuum and also the types of diet the app will offer to follow with the goal to reduce meat consumption

Iteration 1, Role Prototype Concept Testing

Objective: The purpose of this concept testing is to test the idea, raise the problem with the users through the interview, and present them with a simple mi-fi prototype through which the idea is expressed (Bowman, 2017) (Image 5). The objective is to discover the feasibility of a recommendation system used to raise users' awareness of sustainability and therefore their consumption.

Prototype: This role prototype (Houde & Hill, 1997) was based on four simple mid-fi screens designed using Figma. Each of them showed the first main features such as selecting a diet preference, the home page, searching for a supermarket, and browsing the alternatives.

Procedure: The first step was to contextualize the situation with the user. A script was created explaining the objectives of the interview (15 minutes), and the purpose of the prototype (30 minutes). In this case, the conversations were not recorded, instead, notes were taken by the researcher to collect insights. The user was guided through the first steps of the prototype (i.e. choosing a diet or searching for products) but was given full freedom to comment on the steps taken, why they were taken, their thoughts, their needs, or their future expectations regarding the final prototype. This concept testing took approximately 45 minutes with each of the 3 participants.

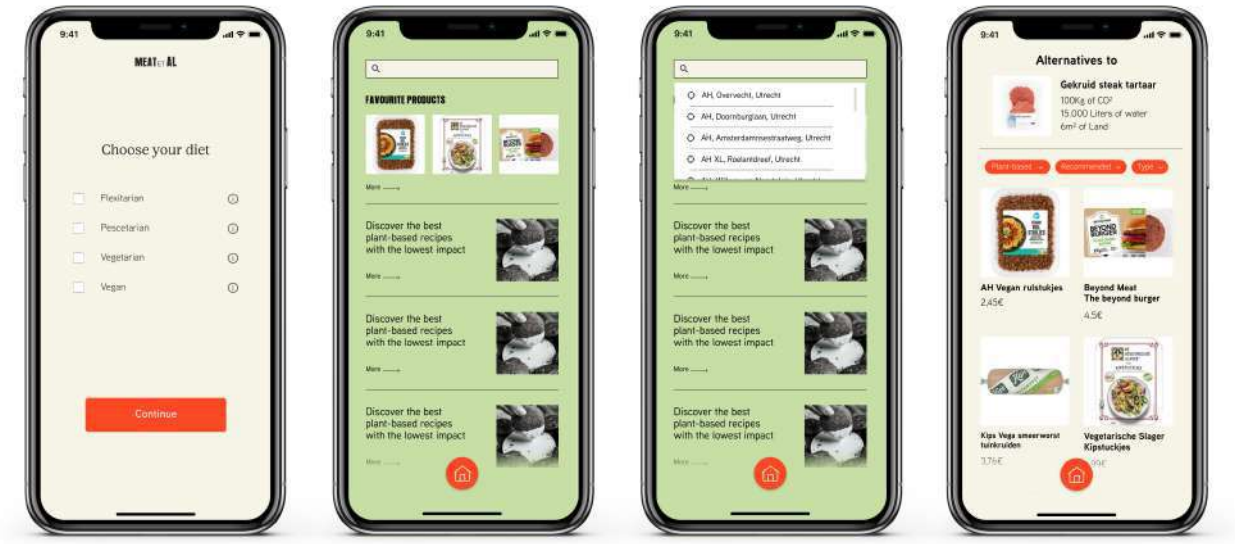


Image 5. Role Prototype, Mid-Fi screens.

Results: After this first iteration, it was possible to understand the users first hand and their answers turned out to be along the same lines as the responses to the questionnaire. In this case, being a much smaller group, all three were surprised to read the environmental data and showed interest in asking more about it. These participants defined themselves as omnivores and shared that for them meat consumption was something they had always known about (biocultural/ biophysical factors), it was beneficial for their health, and although they were aware of what it entailed, they were unaware of the moments in production when this pollution was generated, they were unaware of all the natural resources it required, and they were unaware of the possibilities they had to improve their consumption and continue to be able to consume ABPs, even if only in a reduced form.

Iteration 1 main insights:

"I have friends that shifted to a plant-based diet but for me, I just love meat too much"

"I knew there was issues with the Methane emissions but I wasn't aware of the rest of natural resources"

"I feel like PBPs are way more expensive for me as a student, so I always tend to go for chicken or other ABPs"

"Honestly, I never considered a sustainable diet. I contribute with recycling or saving water but never heard changing my diet for the planet"

Finally, these participants stated that receiving suggestions about their dietary style could be something they would use in the future as long as they knew *why* they were being suggested and were informed of their environmental impact as well as they are informed about the need to recycle, reuse, save water, or use as little plastic as possible.

Iterations 2 & 3, Look & Feel Prototype Usability Testing

Objectives: For the second and third iterations, we will focus on designing the final high-fi designs and a complete user experience through interaction prototyping. The tasks will focus on observing participants using the final designed functions (i.e. create an account, select preferences, navigate the home page, select a supermarket, select the type of food, view alternatives, view additional information, and experience sustainability awareness). The main goal is to detect possible errors in the design, missing features, or how to improve the UX/UI experience.

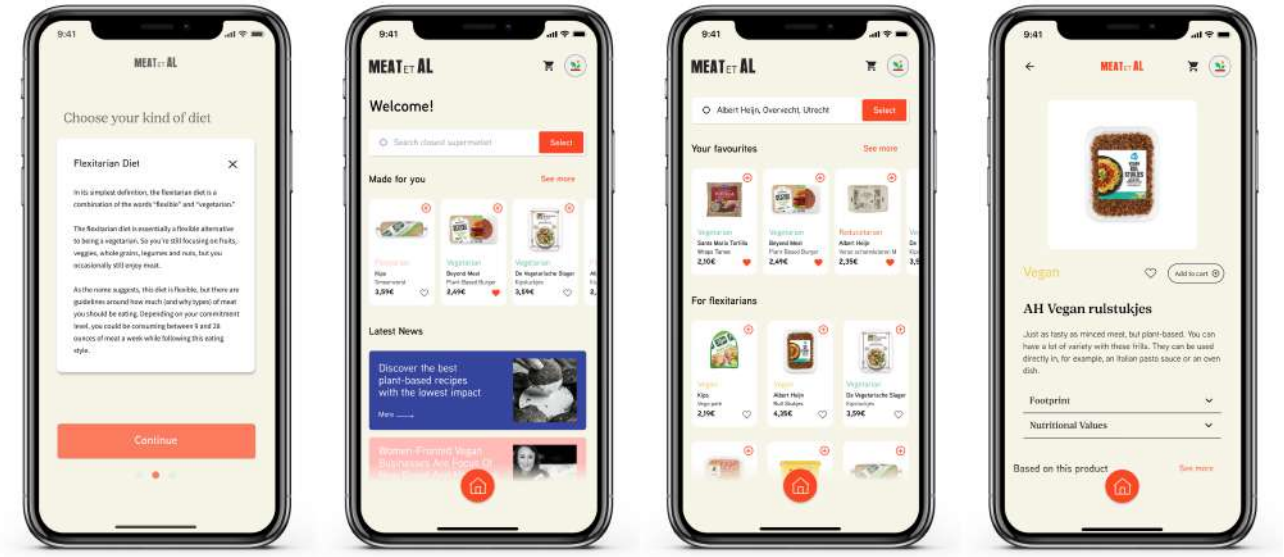
Testing methodology: For both iterations, *Usability Testing* is the methodology selected to ensure that the prototype has been designed for the intended persona, and to test its effectiveness, its efficiency, positive results in its users, and achieves the customer journey experience (Bastien, 2010). At the end of Iteration 3, a brief *A/B testing* will be conducted to help decide the best option for providing and representing sustainability awareness (Kaufmann, Cappé & Garivier, 2014).

Prototype: It will consist of a *Look & Feel prototype,* which means that the UI and UX of the prototype will resemble the final solution as much as possible but without considering the functional part yet (Houde & Hill, 1997). This prototype will consist of the improved screens tested during Iteration 1, and will be tested during both iterations among selected users who previously volunteered. The goal after Iteration 3 will be the final high-fi interactive prototype design.

Procedure: Following the steps of Iteration 1, a script was created to ensure the control of time and tasks to be performed. In this case, the tasks to be performed were conducted and recorded by the researcher and were organized into: 1) *Usability and Structure*, i.e. questions concerning the user experience, the accessibility to the different functions, and the interface architecture navigation. 2) *Look & Feel*, i.e., whether the design systems (colors, fonts, call-to-action buttons, and images) facilitate navigation and accessibility, and achieve user-friendly interactions. Finally, the last five minutes were given to the paticipant to make comments, suggestions, or share their experiences with the researcher. Once the test was completed, a short survey was sent to each participant with 7 multiple-choice questions and 2 short answers regarding the level of difficulty of the exercise, the level of difficulty of the prototype, or the level of awareness encountered.

Iteration 2 results

For this Iteration 2, the designs of Iteration 1 were improved. More information, more organisation, and a more coherent look & feel (Image 6).



Diet explanation

A representation of the information of each of the diets.

Home Page

The Home Page was improved by adding additional information on individual recommendations based on CBF, as well as adding the recommended diet for each product.

Supermarket's place

The flow of the recommendations and the way in which the information is delivered was changed as users mentioned wanting to see the product type or price first before the footprint information

Product information

And finally the first screen was created for additional product information where a description, carbon footprint and nutritional data are the main concerns of the participants.

Image 6. First Look & Feel prototype.

During iteration 2, participants commented on what they did, saw, and felt from their experience. In each of the required tasks, they offered great insights into what they expect to find, how they imagine it, and the things that didn't fit for them in the prototype.

Iteration 2 main insights:

"I'm lacking more information regarding my diet throughout the application. What else can I do with that diet?"

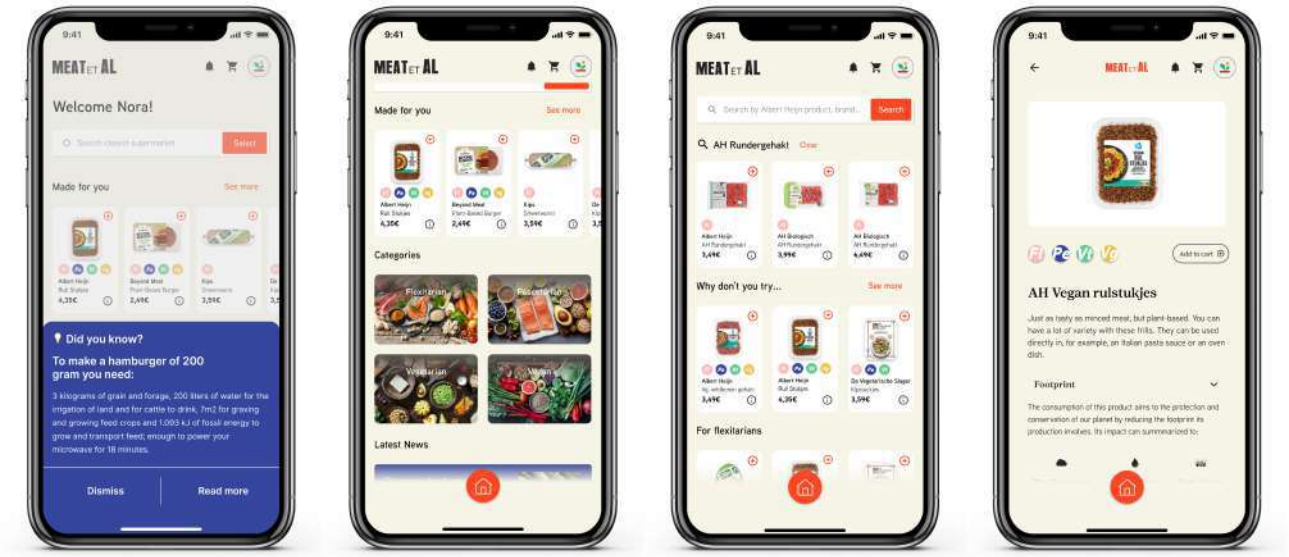
"Does the diet recommendation for the products mean that I can only consume those? I believe there can be more options"

"Where are the rest of the products of AH? Can I make a search by product? How is the recommendation working?"

"Overall, it looks like a very appropriate app to achieve my goal of shifting to a plant-based diet correctly!"

Iteration 3 results

For the third Iteration, adjustments were made to the product descriptions, features were added to the Home Page, the flow of the RS was improved, certain visual elements such as the diet icons were improved, and two new ways of sustainability awareness were added through notifications (Image 7). At the same time, comparisons were made with other online food service platforms such as AH or Gorillas. And finally, an A/B testing was conducted to understand which design layout is more visually understandable for users.



Awareness notifications

Two different ways of providing sustainability awareness were designed and tested with the users.

Home Page

Now on the Home Page, the user can find more information and resources regarding each of the diets. Plus, icons are used instead of the name for the diets recommended for each product.

Supermarket's place

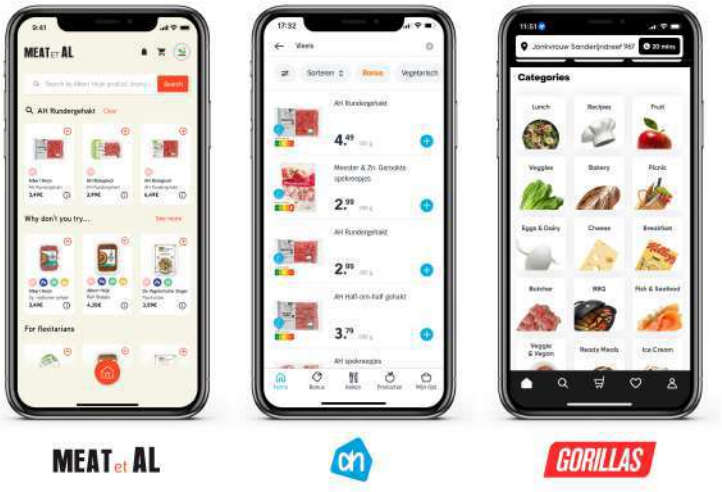
The recommender flow was improve so that users could try how it would look like. The products of AH were also displayed as they do in their online services.

Product information

For the product information, the name of the diet was also turned into icons, and the 'mark as favourite' feature dissappeared to avoid the user from getting the right recommendations based on sustainability.

Image 7. Second Look & Feel Hi-Fi prototype.

Market Analysis



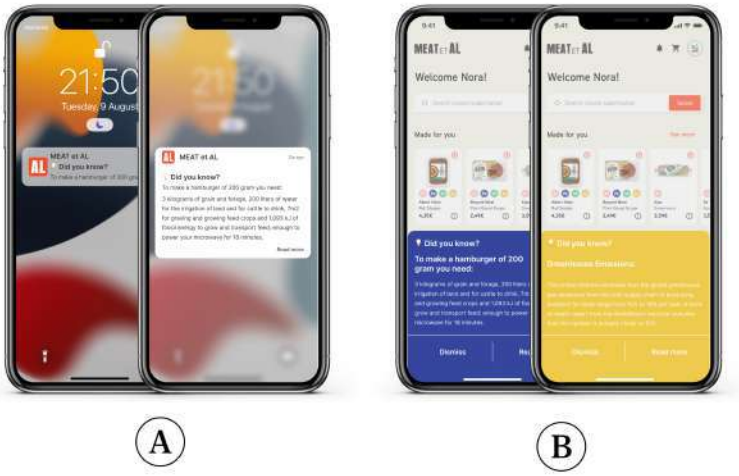
This brief market comparisson was developed to understand how other food applications provide and display their features, information, and products. This research helped understand better three points of view: 1) How AH, the supermarket to investigate, allows users navigate throughout its pages, and what type of information is provided to, in a way, resemble the same experience. 2) Gorillas, a growing food delivery service especially popular among young adult consumers, to also understand the UX flow our persona is used to, the kind of information and the similarities and differences with our prototype.

Each of these applications has a different role to play. AH is a superstore which is both online and offline and offers both in-person and home delivery services but fulfils the role of a supermarket. Gorillas, on the other hand, only offers online express delivery services. Both are independent of each other, and although you can see approaches to both plant-based, vegetarian and vegan

products, their value proposition is not that. MEAT et AL, on the other hand, aims to connect users with large supermarkets such as AH but with the objective of promoting sustainable consumption by focusing less on animal products and more on plant-based products.

Sustainability awarenesss notifications

Some screens such as the supermarket view, the organisation of product information, or notifications were tested in a short A/B testing.



A B

Two different ways of providing sustainability awareness were designed and tested with the users. Option A, are called pushed notifications, and are displayed on the lock screen as other applications such as WhatsApp or Instagram do. According to Newman (2016), this type of notifications, allow us to distribute the information overload by grouping the different app notifications and allowing the user to have an overview of them. The option B are called in-app notifications or prompts, and according to a study conducted by Freyne et al. (2017), users are tolerant to a certain number of prompts during the day or while using the app, but they tend to lose interest in them in the long term.

For this study, it was not feasible to perform A/B testing of the behavioural progression over time due to the scope of the project and also because it was not the objective of the project. However, the study participants marked option A as their preference because they found it less invasive when using the application.

Conclusion

After this third iteration, user responses were more positive than in Iteration 2.

- The RS flow was better represented and showed more coherence.
- Users could enjoy different ways of learning from both their diet and sustainability awareness.
- Products and their recommended diets are clearer thanks to the new icons.
- Product information is reorganised so that the carbon footprint is displayed before the description or nutritional value. In addition, replacing the favourite option with an information icon makes it easier to understand that there is extra information about each product.

Nevertheless, there were also some insights for improvement such as better explaining the supermarket and its location on the supermarket page. Or insights for future improvements such as having dedicated recipes for each diet to learn how to cook certain foods or having an option to track your carbon footprint to see the progress of your consumption.

Through the survey sent after the second and third iterations, a great improvement in accessibility, navigation, and display of the awareness options (Image 8).

	Difficulty of use	Most complex screen	Customer awareness	Awareness encounter	Sustainability-awareness helpfulness
Iteration 2 (Survey)	4,2	Product information	7,8	7	6,5
Iteration 3	2,6	Product information	6	8,5	8,4

Image 8. Survey results Iterations 2 & 3.

Python Prototype Ideation

Data Collection, Python Prototype

As mentioned before, the data collection process followed for the functional prototype started with the manual development of a scraping program using the Python coding language and the development reading environment *Jupyter Notebook* (Image 9). Using the *Beautiful Soup library* for web data collection, what web scraping does is scraping the links from the desired website (in this case www.ah.nl), goes through the data on the website, and finally collects the data needed to turn it into a CSV file (Thomas & Mathur, 2019). One of the main advantages of web scraping is the possibility of collecting data from multiple sources simultaneously. For instance, if you search for a flight from X to Y destination, the chosen browser will only show you the content of the chosen website, however, scraping would allow you to collect real data about that same flight from several selected website and even compare it with each other (Mitchell, 2018). This prototype will not require comparisons from different sources. Web scraping has been chosen primarily because of the lack of an Application Programming Interface or API (a software that allows instantaneous connection and exchange of data) to obtain the desired data (IBM Cloud Education, 2020).

These CSV files have been collected manually by changing the different *keywords* (i.e. vlees or vis) within the scraping code (as shown in Image 9) and creating individual CSV files for each of them. Subsequently, these CSV files have been opened within the *Jupyter Notbook* and put together to create a final CSV file (Images 10 & 11) (see CSV file).

Data Cleaning

In this case, data cleaning has been minimal. Some of the cells were empty because the information for certain products was missing. For this, *df.dropna()* has been used to avoid confusion during FRS programming.

Here we insert the keyword to proceed with the scraping.

```
url = 'https://www.ah.nl/zoeken?query=kip&page=1'
page = requests.get(url)

soup = BeautifulSoup(page.content, 'html')

AH_products = soup.find_all("article", class_="product-card-portrait_root__sZL4I product-grid-lane_gridItem__eqh9g") #
AH_data = []

num = 0
for product in AH_products:

    # Reading from the html element on the results page
    Product_name = product.find("a", class_="link_root__65rmW product-card-portrait_link__1ROKP").get_text()
    Product_price = product.find("div", {"class":["price-amount_root__37xv2 price-amount_highlight__3WjBM price_amount_
    Product_quantity = product.find("span", class_="price_unitSize__8gRVX").get_text()

    link = product.find("a", class_= "link_root__65rmW").attrs["href"]
    print(link)
    completeLink = f"https://www.ah.nl{link}"

    productpage = requests.get(completeLink)
    soupProduct = BeautifulSoup(productpage.content, 'html') # Product HTML page

    # Reading from the product html page. The scraping will read the class, if there's nothing, it will leave it empty.

    try:
        Product_summary = soupProduct.find("div", class_= "product-summary_root__3_CJs").get_text()
    except:
        Product_summary = ""


    try:
        Product_description = soupProduct.find("ul", class_="product-info-description_list__MUNdA").get_text()

    except:
        Product_description = ""

    try:
        Product_ingredients = soupProduct.find("p", class_="typography_root__18FkK typography_variant-paragraph__33rgM

    except:
        Product_ingredients = ""


    AH_list = {"Product name": Product_name, "Description": Product_description, "Summary":Product_summary, "Price": Pr

    AH_data.append(AH_list)
```

Image 9. Writen Scraping Code.

```
In [88]: # Open CSV files

         vlees_df = pd.read_csv("vlees_extra.csv")
         vis_df = pd.read_csv("vis_extra.csv")
         noten_df = pd.read_csv("noten_extra.csv")
         groente_df = pd.read_csv("groente_extra.csv")
         peulvrucht_df = pd.read_csv("peulvrucht_extra.csv")
         zuivel_df = pd.read_csv("zuivel_extra.csv")
         fruit_df = pd.read_csv("fruit_extra.csv")
         worst_df = pd.read_csv("worst_extra.csv")
         salade_df = pd.read_csv("salade_extra.csv")
         gebak_df = pd.read_csv("gebak_extra.csv")
         chicken_df = pd.read_csv("kip_extra.csv")
         cheese_df = pd.read_csv("cheese_extra.csv")
         pasta_df = pd.read_csv("pasta_extra.csv")


         frames = [vlees_df, vis_df, noten_df, groente_df, peulvrucht_df, zuivel_df, fruit_df, worst_df, salade_df, gebak_df, ch

         #final_df = pd.concat(frames).reset_index()
         #display(graduation_df)

         final_df.to_csv("final.csv")
         print(final_df)
```

Final CSV file.

Final dataframe.

Image 10. Combine CSV files into one.

	B	C	D	E	F	G	H
	Product name	Description	Summary	Price	Ingredients	Quantity	key word
0	AH Rundergehakt	RundergehaktVerpakt ond	Rundergehakt om ein	4.89	500 Gram	500 g	Meat
1	Vegetarische Slager Erebu	Veganistische burger op b	De Vegetarische Slag	4.59	2 Stuks. 226 Gra	226 g	Meat
2	AH Rundergehakt	RundergehaktVerpakt ond	Rundergehakt om ein	3.49	300 Gram	300 g	Meat
3	Vegetarische Slager Mc2 b	Vegetarische burger op ba	Dit is het bewijs dat le	2.55	160 Gram	2 stuks	Meat
4	AH Hamburger	RunderhamburgerVerpakt	Hamburgers gemaakt	3.79	400 Gram	4 stuks	Meat
5	Vegetarische Slager Vegan	veganistische stukjes op b	Vegan kipstuckjes var	3.75	160 Gram	160 g	Meat
6	AH Gepaneerde schnitzel	Gepaneerde varkensschni	Een platte schnitzel v	3.39	300 Gram	2 stuks	Meat
7	AH Ontbijtspek	Gerookt ontbijtspekVerpak	Rauw, licht gezouten	2.89	150 Gram	150 g	Meat
8	AH Greenfields Beefburger	Gekruide runderburgerVer	Malse rundvlees haml	3.99	250 Gram	2 stuks	Meat
9	AH Half-om-half gehakt	Half-om-half gehaktVerpak	Half-om-half gehakt o	3.79	500 Gram	500 g	Meat
10	AH Biologisch Rundergeha	RundergehaktSkal 001920 EU-bio-logo NL-BIO-01Verpakt onder l	Rundergehakt van ma	3.99	300 Gram	300 g	Meat
11	AH Mager rundergehakt	Mager rundergehaktVerpa	Mager rundergehakt r	3.59	300 Gram	300 g	Meat
12	AH Biefstuk	RunderbiefstukVacuüm verpakt.		6.37	275 Gram	ca. 275 g	Meat
13	AH Shoarma	Gekruide varkensreepjesE	Malse reepjes varken	4.49	500 Gram	500 g	Meat
14	AH Varkenslavink	VarkensslavinkBeter Voor	Mild gekruid varkensg	3.29	400 Gram	4 stuks	Meat
15	AH Varkensbraadworst	VarkensbraadworstBeter \	Sappige braadworst. (	2.99	400 Gram	4 stuks	Meat

Image 11. Final CSV file.

Recommender System Prototyping

Content Based Filtering

Following the literature review, the author Shubham Kumar (2021) defines an RS as a subclass of information filtering systems that seeks to predict the rating or the preference a user might give to an item (Kumar, 2021). Simply put, an RS predicts the probability of a product being selected by a certain consumer (Zhang et al., 2019, Ricci et al., 2011). Besides *collaborative filtering* (CF), and *hybrid filtering* (HF), *content based filtering* (CBF) is one of the main types of RS that can be found (Melville & Sindhwani, 2010). As opposed to CF (user-to-user recommendations), CBF provides recommendations not strictly based on the collective's interactions but on the comparison of item characteristics (item-to-item) to match the consumer's preferences (Melville & Sindhwani, 2010). The algorithm analyzes the product characteristics such as location, profiles, or descriptions to make recommendations.

For this first iteration of RS, we will use the vector distance, technically called *Cosine Similarity*, between the *'Summary'* variables to generate the first recommendations (Sv, 2020). With this we manage to create the first RS (Image 12). The way it works is by a user product input between the brackets. The RS will provide recommendations of products in the *final_df* that contain, in this case, the word *'Rundergehakt'* within their *'Summary'* variable.

```
In [31]: get_content_recommendations('AH Rundergehakt')
```

Out[31]:

	Product name	Description	Summary	Price	Ingredients	Quantity	key word
32	AH Rundergehakt	RundergehaktVerpakt onder beschermende atmosfeer.	Rundergehakt om eindeloos mee te varieren. Nat...	8.49	1 Kilogram	1000 g	Meat
2	AH Rundergehakt	RundergehaktVerpakt onder beschermende atmosfeer.	Rundergehakt om eindeloos mee te varieren. Nat...	3.49	300 Gram	300 g	Meat
11	AH Mager rundergehakt	Mager rundergehaktVerpakt onder beschermende a...	Mager rundergehakt met minder vet om eindeloos...	3.59	300 Gram	300 g	Meat
29	AH Mager rundergehakt	Mager rundergehaktVerpakt onder beschermende a...	Mager rundergehakt met minder vet om eindeloos...	5.25	500 Gram	500 g	Meat
9	AH Half-om-half gehakt	Half-om-half gehaktVerpakt onder beschermende ...	Half-om-half gehakt om eindeloos mee te varier...	3.79	500 Gram	500 g	Meat
25	AH Half-om-half gehakt	Half-om-half gehaktVerpakt onder beschermende ...	Half-om-half gehakt om eindeloos mee te varier...	2.49	300 Gram	300 g	Meat
63	AH Half-om-half gehakt	Half-om-half gehaktVerpakt onder beschermende ...	Half-om-half gehakt om eindeloos mee te varier...	6.49	1 Kilogram	1 kg	Meat
62	AH Biologisch Bio hoh gehakt 300 gram	Half-om-half gehaktSkal 001920\nEU-bio-logo\n\N...	Half om half gehakt van heerlijk mals, biologi...	3.89	300 Gram	300 g	Meat
10	AH Biologisch Rundergehakt	RundergehaktSkal 001920\nEU-bio-logo\n\NL-BIO-0...	Rundergehakt van mals, biologisch rundvlees. O...	3.99	300 Gram	300 g	Meat
26	AH Biologisch Rundergehakt	RundergehaktSkal 001920\nEU-bio-logo\n\NL-BIO-0...	Rundergehakt van mals, biologisch rundvlees. O...	6.49	500 Gram	500 g	Meat
74	AH Biologisch Mager rundergehakt	Mager rundergehaktSkal 001920\nEU-bio-logo\nNL...	Mager rundergehakt van biologisch rundvlees, b...	4.99	300 Gram	300 g	Meat
741	AH Scharrel kipfilet 3 stuks	KipfiletVers, Klasse A, Scharrelkip binnengeho...	Malse kipfilet naturel van scharrelkippen om e...	9.47	600 Gram	ca. 565 g	Chicken
36	Wahid Rundergehakt	Rundergehakt. Gemalen rundvleesbereidingVerpak...	Fijngemalen rundergehakt van 100% rundvlees.Sa...	6.29	500 Gram	500 g	Meat
696	AH Kipfilet	Kipfiletvers, klasse AVerpakt onder beschermen...	Malse naturel kipfilet om eindeloos mee te var...	9.99	1 Kilogram	1000 g	Chicken

Image 12. Output of the first CBF Recommendations.

The aim of this first iteration was to create the first system and test how it would work. However, the main limitation is that it does not yet generate diet-based recommendations for the reduction of ABPs, which is the goal of this prototype. For this, constraints need to be added, and in this case these will be the diets mentioned previously.

Content Aware Filtering

Following the exploration to address the limitations of CBF for this sustainable-context FRS prototype, researchers propose a shift toward *context-aware filtering* (CA) (Elahi et al, 2015). CA allows for additional variables to be introduced into the algorithm, such as *diets*, to better identify user likes, product ratings, and the link to sustainable-conscious statistics (Elsweiler & Trattner, 2017). In this second iteration, we will take the four diets mentioned above and give them a numerical value: **Flexitarian** 1, **Pescetarian** 2, **Vegetarian** 3, **Vegan** 4. And we will also give each of the keywords the corresponding diets manually: **Meat**: 1; **Fish**: 1,2; **Chicken**: 1; **Nuts**: 1,2,3,4; **Vegetables**: 1,2,3,4; **Fruit**: 1,2,3,4; **Legumes**: 1,2,3,4; **Dairy**: 1,2,3,3; **Cold Meat**: 1; **Salad**: 1,2,3; **Pastries**: 1,2,3; **Cheese**: 1,2,3; **Pasta**: 1,2,3.

Once this is done, we will add the diets as columns and give them numerical value '0' if the diet does not correspond to the product in the row, and '1' if it does (images 13 & 15).

```
df['Flexitarian'] = 1
df['Pescetarian'] = 0
df['Vegetarian']  = 0
df['Vegan']       = 0

for index, each in enumerate(df['key word']):
    if (each != 'Meat') and (each != 'Cold meat'):
        df['Pescetarian'][index] = 1
for index, each in enumerate(df['key word']):
    if (each != 'Meat') and (each != 'Fish') and (each != 'Chicken') and (each != 'Cold meat'):
         df['Vegetarian'][index] = 1
for index, each in enumerate(df['key word']):
    if (each != 'Meat') and (each != 'Fish') and (each != 'Chicken') and (each != 'Dairy') and (each != 'Cold meat') ar
        df['Vegan'][index] = 1
```

Image 13. Diet classification 1.

Once we have the products classified by diet, these receive a final number from 1-4 which is calculated with the sum of the diets to which they correspond. For instance, if a product corresponds *Flexitarian* (1), *Pescetarian* (1), *Vegetarian* (1), *Vegan* (0), the final sum will be 3 and therefore, it will be suitable for those first three diets but will not be shown to a consumer who has selected the vegan diet (i.e. eggs or cheese correspond to that order). Or conversely, if a product has *Flexitarian* (1), *Pescetarian* (0), *Vegetarian* (0), *Vegan* (0), that product will only correspond to those consumers who choose the flexitarian diet but not if they have a preference for any of the other three (i.e. meat or cold meat) (Images 14 & 15).

```
df['diet'] = 0

for each in range(len(df)):
    if (df.Flexitarian[each] ==1)and (df.Pescetarian[each]==1) and (df.Vegetarian[each] == 1) and (df.Vegan[each]==1):
        df['diet'][each] = 4 ## VEGAN

    elif (df.Flexitarian[each] ==1)and (df.Pescetarian[each]==1) and (df.Vegetarian[each] == 1) and (df.Vegan[each]==0)
        df['diet'][each] =3 ## VEGETARIAN

    elif (df.Flexitarian[each] ==1)and (df.Pescetarian[each]==1) and (df.Vegetarian[each] == 0) and (df.Vegan[each]==0)
        df['diet'][each] =2 ## PESCETARIAN

    elif (df.Flexitarian[each] ==1)and (df.Pescetarian[each]==0) and (df.Vegetarian[each] == 0) and (df.Vegan[each]==0)
        df['diet'][each] =1 ## FLEXITARIAN
```

Image 14. Diet classification 2.

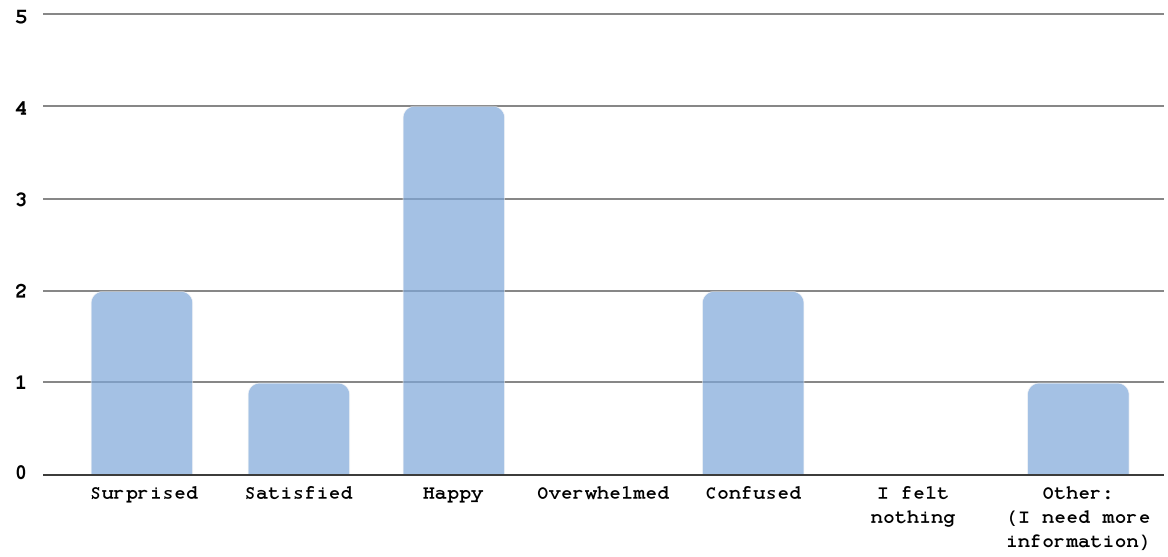
Unnamed: 0	Product name	Description	Summary	Price	Ingredients	Quantity	key word	Flexitarian	Pescetarian	Vegetarian	Vegan	diet
0	AH Rundergehakt	RundergehaktVerpakt onder beschermende atmosfeer.	Rundergehakt om eindeloos mee te varieren. Nat...	4.89	500 Gram	500 g	Meat	1	0	0	0	1
1	Vegetarische Slager Ereburger	Veganistische burger op basis van soja en tarw...	De Vegetarische Slager maakt plantaardig vlees...	4.59	2 Stuka. 226 Gram	226 g	Meat	1	0	0	0	1
2	AH Rundergehakt	RundergehaktVerpakt onder beschermende atmosfeer.	Rundergehakt om eindeloos mee te varieren. Nat...	3.49	300 Gram	300 g	Meat	1	0	0	0	1
3	Vegetarische Slager Mc2 burger	Vegetarische burger op basis van soja, verrijk...	Dit is het bewijs dat lecker eten geen hogere ...	2.55	160 Gram	2 stuks	Meat	1	0	0	0	1
4	AH Hamburger	RunderhamburgerVerpakt onder beschermende atmo...	Hamburgers gemaakt van mild gekruid runcvlees ...	3.79	400 Gram	4 stuks	Meat	1	0	0	0	1
...	...	...	...	...	...	...	...	...	...	...	...	...
304	Valle del sole Zwarte bonen	Zwarte bonen	Een natuurlijke bron van voedingsstoffenGoede ...	1.19	350 Gram	350 g	Legumes	1	1	1	1	4
305	Honig Peulvruchten pasta fusilli kikkererwten	DROGE DEEGWAAR met 50% kikkererwtenBron van ei...	Honig fusili kikkererwten is gemaakt van 50% k...	2.69	300 Gram	300 g	Legumes	1	1	1	1	4

Image 15. Final output of the diet classification

Iteration 4, Implementation Prototype Usability Testing

This *implementation prototype* was tested with 5 participants to confirm its usability both in terms of its actual functioning and its usability in a future final app. After explaining the objectives and functioning of the RS, the participants proceeded to use it to test their reactions. The testing involved three people who defined themselves as omnivores, one person defined as a meat-eater, and one flexitarian between the ages of 20 and 30. According to these five participants, this prototype had a difficulty level of 3.4 in the steps to follow, and 5 in usability, leaving them feeling happy but surprised and confused at the same time. They argue that these results are due to the fact that they understand that it is not a final prototype, but that for the moment it fulfilled its function of showing them recommendations about their diet, but that the information they received and how they received it was confusing and not very precise. However, among the five, they say it could be a good tool for better sustainable consumption (82%) and how likely they will start following a diet low in ABPs is 78%. Finally, when asked what other preferences they would like to have, the answers were surprisingly unanimous naming issues such as health (naming allergies), sport (mentioning following specific diets), money (being a student), and finally one person would like to be able to restrict the foods they do not like.

How did you feel after receiving the recommendations? (Select 2)



Could you briefly explain why?

It was interesting to see new ways of consuming meat.

Never consider having recommendations but as a flexitarian I was happy to make a more sustainable shopping of food.

I didn't think this was possible for my diet but I was missing a bit more of information.

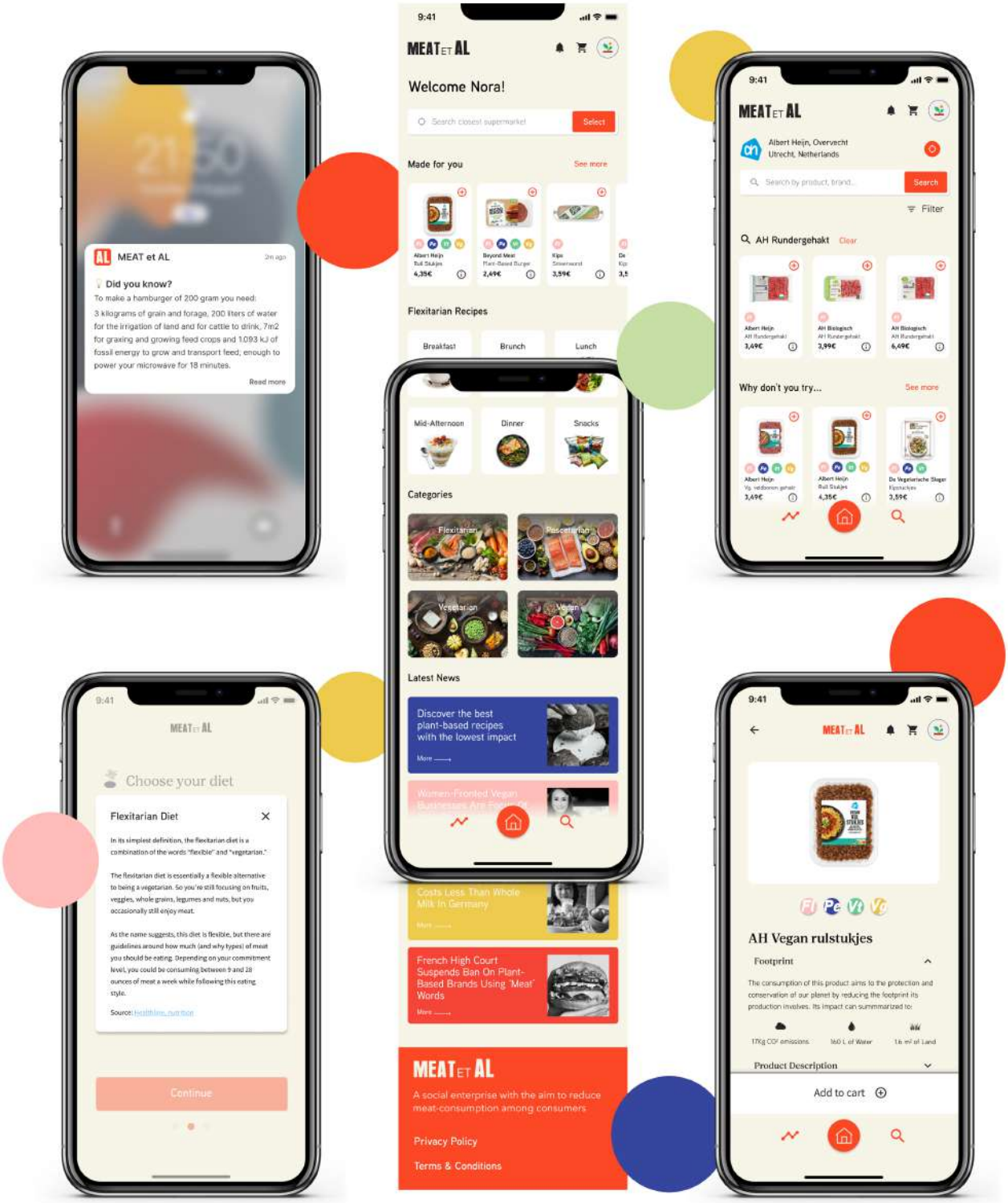
I liked seeing it work but the information was confusing.

I was happy to see it worked but confused by the information.

Figure 3. Answers to the effect of the recommender system prototype.

Outcome

Final main screen flows designed in Figma.



Final Figma recommender system screen flow.

Final Python Recommender System Prototype Flow.

```
def get_content_recommendations():
    print('Please choose your diet')
    print('Press 1: Flexitarian')
    print('Press 2: Pescetarian')
    print('Press 3: Vegetarian')
    print('Press 4: Vegan')
    diet_type = input()
    diet_type=int(diet_type)

    keyword = input('Please enter a keyword to find a product: ')

    list_of_product = []
    for index, each in enumerate(df['Product name']):
        if keyword in each:
            list_of_product.append(each)
    print('Plese choose your item based on keyword search!')
    for i in range(len(list_of_product)):
        print('press', i,'for',list_of_product[i] )
    a = input()
    title = list_of_product[int(a)]
    print('Choosen item is: ', title,'.')
    try:
        # handle case in which book by same title is in dataset
        idx = indices[title][0]
    except IndexError:
        idx = indices[title]
    sim_scores = list(enumerate(cosine_sim[idx]))
    sim_scores = sorted(sim_scores, key=lambda x: x[1], reverse=True)
    sim_scores = sim_scores[1:6]
    product_indices = [i[0] for i in sim_scores]
    new = titles.iloc[product_indices]
    return new[new['diet'] > diet_type]
```

```
Please choose your diet
Press 1: Flexitarian
Press 2: Pescetarian
Press 3: Vegetarian
Press 4: Vegan
2
Please enter a keyword to find a product: Fish
Plese choose your item based on keyword search!
press 0 for Fish Tales Gerookte Sockeye zalm 100g
press 1 for Fish Tales Ansjovis filets in olijfolie msc
press 2 for Fish Tales Skipjack tonijn in water
press 3 for Iglo Fishcuisine Bretagne
press 4 for Fish Tales Gerookte zalmsalade
press 5 for Fish Tales Tonijnsalade
2
Choosen item is:  Fish Tales Skipjack tonijn in water .
```

	Product name	Description	Summary	Price	Ingredients	Quantity	key word	Flexitarian	Pescetarian	Vegetarian	Vegan	diet
525	Fish Tales Tonijnsalade	TonijnsaladeVerpakt onder beschermende atmosfeer	Fairrukkelijk! Heerlijk frisse en rijkgevulde ...	1.91	125 Gram	125 g	Salad	1	1	1	0	3
742	AH Witte kaas plak	Witte kaas 45+	Ah witte kaasplak is een stevige verse kaas me...	1.29	200 Gram	200 g	Cheese	1	1	1	0	3

Limitations and future improvements.

Although a significant total number of participants volunteered throughout the project for the questionnaires, interviews, user testing, or for the expert interviews, the results of this research still make up too low a number of the study group to be statistically accepted. For example, according to Graglia (2022) it would take around 100 participants in the first questionnaire (quantitative data) to have a validation with a 10% error. The more participants, the smaller the error and the better the results. Therefore, in the future, the population to be studied should be carefully considered in order to be able to calculate a good number of participants.

Regarding the data collection for the prototype implemented, besides the 910 products for the RS, these together with the selected keywords do not cover the entire selection of products offered by AH. For greater precision, it would be necessary to obtain the entire product base of the chosen supermarket in order to be able to confirm and work on the recommendations. In addition, this data collection has only focused on one large supermarket out of the 8 supermarkets in the Netherlands that were presented in the first questionnaire. Comparisons would need to be made between the supermarkets themselves and it would probably be necessary to adjust the programme and the variables to the data for each supermarket and each product.

On the other hand, some of the products selected for each keyword also included products for vegans (i.e. Dairy also included soy or oat milk). Therefore, within this recommendation and simple distribution of the products by diet, it would be necessary to be much more precise. It would be needed to develop a code that at the same time differentiates these products according to keywords, information within their data, or even according to the extra content-based variables mentioned above such as allergies, lifestyles, or working status. In this case, the recommendations have been kept this way to facilitate the execution, avoid the bad distribution of time, and test the concept behind the RS.

This project targets a certain part of the population (young adults located in the Netherlands). Although it has been proven on a small scale that the problem exists, that we need to raise awareness, and that there is a possibility to use technologies to our advantage, we do not know how this kind of solution would affect or be reflected in the older population. As the consumer behaviour expert explained, in a supermarket like AH these low-animal products or PBPs have a very focused buyer who is the young consumer. However, it would be necessary to study the older consumer to generate solutions that adapt to their needs, wants and context. As well as studying different demographics to understand consumers in countries other than the Netherlands.

Takeaways

The aim of this study has always been to provide a solution to reduce the consumption of ABPs among young adults by raising awareness of the environmental problems caused by their production and consumption. Through the use of technologies like FRSs, a functional prototype based on CA filtering has been developed, which analyzes the type of dietary preference of the consumer (i.e. flexitarian), and compares it with the selected supermarket products to generate recommendations on alternatives to that product. These alternatives are intended to benefit both the reduction of ABPs in their purchase, as well as raising sustainability awareness of their purchase to achieve sustainable consumption. The prototype designed in Figma aims to test awareness theories like Mezirow's TLT throughout the touchpoints of the UX so that the consumer follows a journey of dilemma, "*What is happening?*", awareness, "*I am informed of what and why*", attitude, "*I understand the problem and I have the solution*", and finally action, "*I choose these recommendations for the environmental and my own well-being*". This final prototype will assist users in raising awareness through notifications, product information, diet information, and news.

This study together with both prototypes has proven to spark interest among the participants and corresponds to the theories and studies analysed throughout the literature. Contributing to a young population has helped to better understand the concerns of the younger generation in the environment, in their consumption patterns, and in their health. These participants value having choices that are both beneficial to the environment and to their health and are therefore willing to change their dietary style to a reduced ABPs diet if it contributes to their goals and they are offered a reason why (more than 65% positive responses). On the other hand, it is true that some of these participants have a certain attachment to products such as meat or cheese either because of the taste or because of the cultural role that certain foods have for them. Nevertheless, more than 65% of participants still answered *'Yes'* to looking for alternatives to reduce their consumption of ABPs to once or twice a week. For those reasons, both prototypes have been favorable to these results for providing new sustainable consumption tools without altering the interaction with other grocery apps. In short, the development of FRSs focused on the environmental and sustainable sphere, together with an in-depth study of user behaviour for greater sustainability awareness, is a field that still needs to be researched in the fight against climate change.

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