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## Universal Design of ICT

# Know your food products through mobile app

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# Preface

Choosing to focus my thesis on how a universally designed smartphone application for nutrition values in plant-based food products may affect people, was a natural choice for me. I am quite interested in the universal design of smartphone apps. My interest in it peaked during a summer internship where I worked on the design, including universal design, of a smartphone application. As I am vegetarian, I wanted to focus the prototype application on nutrition in plant-based food products. During the work on this thesis, I have learned a lot about universal design and the importance of including users throughout the process, but also about nutrition and a healthy diet. Thus, my health literacy has increased.

I could not have done this master thesis without support, guidance, and participants. My supervisors, Way Kiat Bong and Norun Christine Sanderson have made it possible for me to write this thesis and guided me throughout the whole process. The methodology used, user-centered design, required participants, and I would like to thank everyone who participated in the questionnaire and the user testing. Lastly, I would like to thank friends and family for supporting and helping me. Thank you all.

Oslo, May 10, 2022

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# Abstract

The numbers for obesity and other diseases related to an unhealthy diet are high and increasing globally. Information about nutrition values in plant-based food products is not accessible enough. This master thesis aims to investigate how a universally designed smartphone application where consumers can easily assess and compare the nutritional value in plant-based food products can change people's behavior and mindset towards a healthier diet. It focuses on how individuals may use such an application for making healthier decisions and how it may create awareness of nutrition values in plant-based food products compared to meat products.

To investigate how such an application would or would not impact people, User Centered Design was used to create a prototype application and investigate its effect. Thus, users were included throughout the process to design and evaluate a prototype application with high usability. User testing was applied to get feedback on how users would use the application and how it would affect them. The findings indicate that the prototype application have potential to create awareness and affect the users' decisions in making a choice. They would use it for finding healthier options for food products. These results may suggest that such smartphone applications can help individuals towards a healthier diet.

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# 1. Introduction

Eating plant-based is becoming increasingly popular around the world. Eating more plant-based is both more environmentally friendly and healthier. Meat consumption is found to be positively related to obesity according to an analysis of nationally representative data collected in the 1999-2004 national health and nutrition examination survey (Wang & Beydoun, 2009). According to the World Health Organization (WHO) (2021), one-third of the world's population is "affected by at least one form of malnutrition." Obesity, diabetes, hypertension, and cardiovascular disease are all disorders linked to diet and lifestyle choices, and eating more plant-based foods may lessen the risk of these diseases as well as related difficulties with the quality of life (Tuso et al., 2013, p. 1). Plant-based diets contribute to some of the United Nations Sustainable Development Goals, including good health and well-being (goal 3), responsible consumption and production (goal 12), and climate action (goal 13) (United Nations, 2015).

Plant-based diets are currently being promoted by the media in a variety of ways, including documentaries, social media, and articles. The positive aspects of such a diet are continually emphasized. Although there is a growing awareness of it, there may still be a shortage of freely accessible information about the nutrition of a plant-based diet. The number of google searches connected to plant-based diets increased dramatically in the month following the debut of the Netflix documentaries "What The Health" and "The Game Changers", which support such diets (Hartwell, M. et al., 2021). Although the interest for a plant-based diet may have peaked, numerous questions remain. Eating plant-based may be healthier from a general point of view, but there is still a huge variety of nutrition values in all the various plant-based products

There is not enough accessible information about nutrition values in plant-based food products. WHO (2021) states that there is a lack of health literacy, specifically nutrition, and is working towards making it more accessible. Tangsripairoi et al. (2019, pp. 61-66) found that few of the many health and diet applications have information or comparison of nutrient values, which they later found to be a very popular feature in their mobile application. The number of people affected by obesity

and overweight, and diseases related to an unhealthy diet, is increasing globally (WHO, 2021). The consequences may affect the quality of life and many times lead to death. WHO (2021) states that at least eight million people die due to an unhealthy diet each year. Those who produce food often do not think about how the consumer will get information regarding nutrition values. Their focus may be on convincing the consumer to select their product instead of other, to sell more.

Today's technology brings opportunities for new ways to help people change their lifestyles. There is a global interest in mobile health (mHealth), which supports people medically through mobile devices (WHO Global Observatory for eHealth, 2011). According to Direito et al. (2014), as many as 19% of smartphone owners in the US have downloaded an application to manage their health. Most of these do however not support features related to nutrition values. This may imply that there is an interest in such applications.

Although there are many smartphone applications, many are not universally designed from the beginning (Walker et al., 2017, p. 1). The awareness of Universal Design and its importance has increased in the last years, but there is still room for improvement. Mobile applications should be usable by all users, to the greatest extent possible. Although there is generally low health literacy in the world, some populations are more likely to have low health literacy (U.S. Department of Health and Human Services, 2010, p. 8). This may imply that the available information is not accessible or universally designed enough. While everyone has personal dietary needs, the fundamentals and importance of a healthy diet relates to all (World Health Organization, 2020).

A universally designed web application for assessing and comparing nutrition values in plant-based food products has already been developed and shows great potential (Bong, 2022). It has received promising feedback through focus group interviews, but also areas for improvement. This master thesis extends the "An Accessible Web Application of Food Products Focusing on Plant-based Diets for Better Health" project (Bong, 2022). In this master thesis a mobile application was designed to further research the role and potential effect of making nutrition values in plant-based food products more accessible digitally. Many people may benefit from this as it potentially can help people change their behavior toward a healthier diet.

This master's thesis argues that more knowledge and awareness of plant-based food products and their role in a healthy diet may help people make healthier decisions. The role of a universally designed mobile application with such information was researched. The following research question and sub-questions are the basis of this master thesis.

**To what extent can a universally designed smartphone application where consumers can easily assess and compare the nutritional value of plant-based food products change people's behavior and mindset towards a healthier diet?**

**How can it help people make healthier decisions regarding their diet?**

**How can it help people be more aware of nutrition values in plant-based food products compared to meat products?**

The development of a mobile application that provide information on plant-based food products allowed for further reasoning on these research questions. The application was developed through user-centered design, and thus there was feedback from users throughout the development process. While the first iterations of feedback focused on improving the design, the last ones were directed towards answering the research questions above.

## 1.1 Ethical considerations

This research involves participants, and ethical aspects must therefore be considered. It was important that the participant participated voluntarily and that they were not harmed in any way or form. Participants and their data had to be anonymous and not identifiable. To clarify and ensure this to the participants, consent was required before any involvement in this research. Informed consent was given orally or by accepting a questionnaire. Clear information about the purpose of the research was given before users gave consent and participated in user testing or answered a questionnaire. When collecting personal data for research in Norway, one must notify the Norwegian center for research data. "Personal data is any data that can be linked to a person. Personal data can be, for example, national ID

number, name or e-mail/IP address.” ("Notification Form for personal data | NSD", n.d.). They also state that notifying them is not necessary if data is gathered anonymously. No personal data was gathered in this research and the Norwegian center for research data was therefore not notified.

# 2. Literature review

This section describes related literature. Research, statistics, and information on plant-based diets, health literacy, and universal design are described. Similar research is also included here.

## 2.1 Plant-based diet

The amount of people affected by overweight and obesity are increasing all over the world (WHO, 2021). Preventing and reducing the risk of diet- related diseases are becoming increasingly important. According to the Norwegian Directorate of Health (2010) increasing the consumption of vegetables, fruit, and whole grains, while decreasing the consumption of meat and dairy products, can help reduce the risk of diabetes type 2 and metabolic syndrome. In an analysis, they also found that five portions of fruit and vegetables each day reduces the risk of heart disease by 17 percent. Thus, their recommendation for preventing and reducing symptoms of such diseases includes eating more plant-based products. Eating more plant-based food products may be an important factor in the current rise of diet-related diseases.

Tuso et al. (2013) performed a case study in which they wanted to give physicians an update on plant-based diets. They wanted to improve health outcomes through cost-effective interventions, such as a plant-based diet. A plant-based diet can also decrease body mass index, blood pressure, and cholesterol levels, as well as the amount of medications needed to manage chronic diseases and lower ischemic heart diseases mortality rates (Tuso et al., 2013). The case study was done on a 63-year-old man who had hypertension and complained about fatigue, nausea, and muscle cramps. He also had diabetes type 2. Over a period of 16 weeks, he had a low-sodium, and plant-based diet that meant no animal products or refined sugar, while also reducing bread, rice, potatoes, and tortillas to once a day. He also started exercising 15 minutes twice every day. After the 16 weeks had passed, they got positive results that exceeded what would be expected with just the exercise. Thus, they found his new diet to significantly improve his biometric outcome measures, and he could stop taking and reduce several of his previously prescribed medication.

Plant-based diets are getting more popular, and many media platforms are creating more awareness of such diets. Hartwell, M. et al. (2021) used Google trends to analyze the frequency of plant-based related keywords before and after the release of two Netflix documentaries, “What The Health” and “The Game Changers”. Both aimed to increase awareness of plant-based diets among their viewers. Their analysis showed that the google searches for “plant-based diet” increased significantly in the month after the release of these two documentaries. It increased by more than double the average predicted. Also, the search for “vegan nutrition” was more than twice the forecasted numbers. Hartwell, M. et al. (2021) concludes that there is increasing popularity of plant-based diets, but that this may be due to a trend rather than based on science or personal needs. More research and awareness of the health benefits of such a diet and how to adjust it to personal needs are encouraged.

## 2.2 Health literacy

Health literacy is complex but can be defined as “the degree to which individuals have the capacity to obtain, process, and understand basic health information needed to make appropriate health decisions.” (U.S. Department of Health and Human Services, 2010, p. 1). WHO (2017) states that there is generally low knowledge about health, not just in developing countries, but also in developed countries. According to the U.S. Department of Health and Human Services (2010), 88 percent of adults who speak English in the United States do not have proficient health literacy skills. The low health literacy in the world and the high numbers of people with diet-related diseases can suggest that there is a relation between the two. Increasing health literacy is important for preventing the appearance of noncommunicable diseases.

Although low health literacy is a global problem, it is more frequent in some populations. According to the U.S. Department of Health and Human Services (2010) “adults over the age of 65, racial and ethnic groups other than White, recent refugees and immigrants, people with less than a high school degree or GED, people with incomes at or below the poverty level, and non-native speakers of English” are more likely than others to experience limited health literacy. They also found people with

various disabilities to face barriers to gaining health literacy. Although this is from 2010, it may still indicate that health information is not accessible enough.

## 2.3 Universal design in mobile applications

Many human-computer interaction systems are not universally designed, and thus leave out many people. One can refer to this situation as a disability where a gap between individual abilities and the requirements of the system occurs (Fuglerud, 2014, p.17). Universal design may be an approach toward closing or minimizing this gap, and can be defined as “an approach to design that incorporates products as well as building features and element which, to the greatest exten*t* possible, can be used by everyone” (Crews & Zavotka, 2006). In Norway, universal design of ICT solutions is a part of the Anti-discrimination Act (Equality and Anti-Discrimination Ombud Act, 2017). However, according to Stephanidis (2007), there is still a lack of awareness of universal design. The Center for Universal Design with funding from the U.S. Department of Education’s National Institute on Disability and Rehabilitation Research created seven principles of universal design in 1997. (Story, 2001)

1. Equitable use.
2. Flexibility in use.
3. Simple and intuitive use.
4. Perceptible information.
5. Tolerance for error.
6. Low physical effort.
7. Size and space for approach and use.

These principles may be up for interpretation and adaptation, but the World Wide Web Consortium provides guidelines specifically for how to make mobile applications accessible for as many as possible (Patch, Spellman & Wahlbin, 2015). They have created a document to make it clear what the best practices for designing mobile applications are. Thus, everyone involved in the process of developing mobile applications should be familiar with this document.

Walker et al. (2017) examined a universally designed weather application and discussed the effect of it being universally designed. Many people are interested in

checking the weather, and there are numerous smartphone applications for it. These applications should be accessible by all, but many of them are not. Walker et al. (2017) state that there is a lack of research on universal design and knowledge about its effect. Through the paper, they developed and tested a weather application that was focused on universal design from the beginning of the development process. The application received positive feedback from a wide range of users. They concluded by encouraging all future Application development to use universal design from the beginning of the development.

## 2.4 Smartphone applications for diet

Southey (2019) performed an independent study on the “French smartphone application Yuka, which aims to help consumers choose products good for their health.” Through the application, users can scan barcodes on food products and get detailed information in regards of health, including a rating. The rating is based on the “European Nutri-Score calculation method”. “Nutri-Score” is developed by French scientists where the nutritional values place products on a scale of “A”, which means the “most favorable”, to “E”, the “least favorable” (WHO: EU-wide introduction of Nutri-Score necessary, 2021). If the product is unhealthy, it recommends healthier products. Yuka, with more than 10 million users, has expanded beyond France to Belgium, Switzerland, Luxembourg, Spain, and the UK (Southey, 2019).

The study included 18 participants between the age of 26 and 65 years old, with two-thirds being female and the rest male (Southey, 2019). They came from various professional backgrounds, such as managers, students, and retirees. In general, they found Yuka to have changed people’s shopping experience for the better. It gives easy access to easily understandable and detailed information about how healthy products are. Especially processed or new food products were the most scanned products. On the other hand, they also found that the users sometimes chose not to use the application or follow its advice. When deciding on what to buy, nutrition is not the only factor that is taken into consideration. Sometimes, people are aware that products are unhealthy, but still want to buy them. Most people also have their favorite products, and it may be difficult to change these. Many people shop for the whole family, and it may not be popular to bring home a different product than what the family is used to and like. If a user wants to choose the healthier option,

price and availability were found to be part of the decision for many of the participants. Despite this, Yuka was found to make people more aware of how healthy the products they consume are and simplify their decisions at the grocery store.

Another research project, APPETITT (Farsjø & Moen, 2016) focused on making a universally designed application specifically for elderly people with nutritional challenges. The aim was to encourage them to eat by helping them plan meals. The research included a four-week test period for four elderly participants. Through focus group interviews, they got feedback. APPETITT was found to be easy to use and the participants got inspired to make some of the suggested recipes. Two of them found the app to help them be more aware of their food choices. The application was universally designed, but still had room for improvements. The focus group interviews revealed that some functions did not get used. The notification function was only noticed by one participant. The researchers did however state that they did not know if this was caused by the prototype not working properly or the users not hearing it. There was also a wish for more personalization as the users have different preferences for settings and meal suggestions. Although this was a rather small test group, such applications may be helpful for the elderly.

Tangsripairoi et al. (2019) also researched how a smartphone application can help people be more aware of their consumption of various nutrition. Through a user survey of 83 participants, they found that only 7% clearly understand the nutrition facts label on products. There exist many smartphones application for managing diet, but few of them include nutrition analysis or nutrition information. Tangsripairoi et al. created an application, WhatTheHealth, which included these features along with other features such as calculation of calories, food guide, achievement, and barcode scanner. After testing WhatTheHealth on 40 participants, it got positive feedback and had an average satisfaction score of 4.03 out of five. Also, the “compare nutrition” feature was the most liked feature, with a rating of 4.625 out of 5 (highly satisfactory). It was here concluded that WhatTheHelath created more awareness of a healthy diet and consequently reduce the risk of diet-related diseases.

Schoeppe et al. (2016) performed an analysis of available studies with research on mobile applications for improvement of behavior related to health, such

as diet. They wanted to measure how well such applications work and if users change their behavior. Reviewers analyzed each study and its methodology independently. They included 27 studies that targeted various audiences and changes of behavior. 13 of the studies targeted diet, and seven of these studies showed significant health improvement. Also, most of the studies targeting improvement of physical activity and sedentary behavior showed significant improvement. They found more usage of the applications to be positively associated with better health outcomes. They state that some of the studies used poor methodologies and thus were less trustworthy. This analysis implies that mobile applications for behavior change related to the improvement of diet can be effective. The researchers did however not know why some of the studies showed potential while some did not.

West et al. (2017) did a study in which they wanted to see how diet and nutritional applications are related to behavior change in users. They performed a cross-sectional survey with 217 participants. After using regression analysis, they found such applications to be strongly linked to behavior change. Most of the participants got more motivated to eat healthy when using diet or nutrition applications. They state that such applications that focus on knowledge, among other things, can be very useful.

Vasiloglou et al. (2020) looked at what health care professionals think about nutrition and diet applications. 1001 health care professionals completed a survey of 23 questions. The health care professionals were very diverse. There were both women and men from many different countries, who worked as dietitians, doctors, nurses, and other professionals. It was found that 45.4 percent of the health care professionals had recommended a nutrition or diet application to their patients earlier. They state that “there is room for improvement and broader adaptation of such applications to dietic practice as mHealth research is rapidly developing” (Vasiloglou et al, 2020, p. 14) and that there should be more research on what kind of role such applications can have in dietary monitoring and assessment. They conclude that nutrition and diet applications should be free to download, user-friendly, and many of the health care professionals preferred them to be validated.

Lastly, this research done in this thesis, extends a project in which a web application for nutrition in plant-based products has been created and researched. This website aimed to “design a web application where nutrition information of plant-based food products can be accessed by the consumers.” (Bong, 2022). The researchers used user-centered design and performed a series of focus group interviews to get feedback on the web application. They found it to be easy to learn and use, but the design was found to be “too simple” and “appeared less attractive” for younger users. Although there is room for improvement, the research suggests that more accessible and comparable information about nutrition in plant-based products may be useful.

# 3. Methodology

A user-centered design (UCD) approach and techniques were used to develop a highly usable application prototype and investigate the research question and sub-questions:

> *To what extent can a universally designed smartphone application where consumers can easily assess and compare the nutritional value of plant-based food products change people's behavior and mindset towards a healthier diet?*
>
> *How can it help people make healthier decisions regarding their diet?*
>
> *How can it help people be more aware of nutrition values in plant-based food products compared to meat products?*

A questionnaire, user testing, and feedback analysis are among the techniques used. This section describes these techniques and the execution of them in this thesis.

## 3.1 User-centered design (UCD)

UCD was found to be a good approach for the research in this thesis as it focuses on making the prototype application usable for its purpose and users. "The goal of UCD is to produce products that have a high degree of usability" (Henry & Thorp, 2004). In this case, usability can be defined as the extent to which the application prototype can be used by users to help them eat healthier (Henry & Thorp, 2004). To better investigate the effect of the prototype application, it had to be highly usable. If the users were not able to use it for its purpose, results could have been compromised.

Users were included throughout the process of developing a prototype application. By using UCD techniques, involving users, from the beginning of the process, the application interface it better adapted to an environment and potential

users (Karat, 1997). UCD techniques allows for a better understanding of its effect on the users may be revealed.

The process started with a questionnaire to get a better understanding of what potential user think about and want in an application for nutrition in plant-based food products. The analysis of the responses shaped the requirements for the application. Based on the requirements, a sketch was drawn, which was the base of the first high fidelity prototype, designed in Figma. Three iterations of user testing, analysis, and redesign were then executed.

## 3.2 Questionnaire

A questionnaire was conducted at the beginning of the process to shape the requirements for the application. “It is not sufficient to develop a new computer interface without researching the need for the interface and without following up with user evaluations of the interface” (Lazar et al., 2017, p. 7). It does not collect as in-depth data as other research methods may do, but gives an overview of what people think about an application for diet.

The questionnaire aimed to get a better understanding of potential users’ habits and opinions regarding a healthy diet, and the role a smartphone application may have. A survey is “a well-defined and well-written set of questions to which an individual is asked to respond.” (Lazar et al., 2017, p. 105). It may help identify the interest of the application, what users may want in it, and help form the first prototype. It is an efficient way to reach many people in different locations, and thus get an overview of their current habits, their opinion on something, and what they may want in an app (Lazar et al., 2017).

Convenience sampling was used for getting respondents. Convenience sampling means that participants were selected because they were easily accessible and convenient to recruit (Sedgwick, 2013). This saved time and effort, but some disadvantages may have been present. Participants might have been biased, and populations might have been overrepresented or underrepresented (Jager et al., 2017). To create a broader and more diverse set of total participants, they were encouraged to forward the questionnaire to others. Everyone was given detailed

information about what data was collected and what it was used for before starting the questionnaire and thus giving their consent to participate.

The questionnaire was created in google forms. Google forms is easy to use, and many are already familiar with it. It summarizes and analyses responses and allow for further analysis through google sheets. The questionnaire was created in English as it is considered a lingua franca. This allowed for participants from various backgrounds.

The survey consisted of three sections with a total of 14 questions. The first sections consisted of some background questions which was useful for putting the responses into context (Rogers et al., 2015). The two following sections asked questions regarding diet and the potential role a smartphone application could have. The sections and questions asked in the questionnaire are listed below:

**Section 01 - Background questions**

1. What is your age? (Mandatory – Short-answer text)
2. What is your gender? (Mandatory – Multiple choice: Male / Female / prefer not to say)
3. Which country do you live in? (Mandatory – Short-answer text)
4. What is your level of education? (Mandatory – Multiple choice: High school / Bachelor / Master / PhD or equivalent / Other)
5. Do you have any special diet? (Mandatory – Checkboxes: Vegetarian / Vegan / Gluten-free / Pescatarian / None / Other)
6. If yes, what is the reason? (Voluntary – Checkboxes: Religious / Ethical / Health / Financial / N/A / Other)

**Section 02 - Diet**

7. How often do you eat plant-based meals? (Mandatory – Multiple choice: Daily / Multiple times a week / Weekly / Occasionally / Never)
8. If never, why? (Voluntary – Long-answer text)
9. How concerned are you about eating healthy? (Mandatory – Linear scale: 1 (Not at all) to 5 (Very))

10. What is your level of knowledge of what is in plant-based food products? (Mandatory – Linear scale: 1 (None) to 5 (Total))
11. Do you think there is a lack of easily accessible and comparable information about the nutrition of plant-based food products? (Mandatory – Linear scale: 1 (Not at all) to 5 (definitively))

**Section 03 - Smartphone application**

12. Do you think a mobile application where you can access and compare plant-based food products will help you choose healthier food products? (Mandatory – Linear scale: 1 (Not at all) to 5 (Definitely))
13. How much more often would you choose to eat plant-based meals if you had such an application? (Mandatory – Linear scale: 1 (Not at all) to 5 (Much more often))
14. Are there any features you want in a mobile application for accessing and comparing plant-based food products (Voluntary – Long-answer text)

## 3.3 Prototype design

An application prototype was created using Figma. Figma is a free online tool for creating interactive prototypes ("About Figma, the collaborative interface design tool.", 2022). Figma is easy to understand and use, and previous experience with this tool was an advantage. Their vision is to “make design accessible to everyone”. Thus, Figma was found to be the most suitable tool for creating the prototype.

The design process started with some sketches on paper before creating a high-fidelity prototype in Figma. Sketches were made based on the requirements. After sketching on paper, the process of creating an interactive high-fidelity prototype in Figma began. This process consisted of three, previously mentioned, iterations. Due to time and scope, not all buttons were clickable. There were created interactive flows that would represent the intention and usage of the application. This made it possible to perform user testing.

## 3.4 User testing

The user testing aimed to improve the usability of the interface, while also investing if, and how it affected users toward a healthier diet. Usability testing is a way of seeing how a user interacts with an interface where the goal is to improve the interface (Lazar et al., 2017). Such tests allow for a better understanding of the potential users of the interface. The user testing was executed in Figma mirror. Figma Mirror is a smartphone application that displays the prototype created in Figma on the phone. It allows the user to hold a physical phone and interact with the prototype. The prototype was developed for iPhone 11 and thus tested on an iPhone 11. Also here, convenience sampling was used. It was however a requirement that the participants understood Norwegian and had little or no prior knowledge about the look and functionality of the application prototype. The purpose of the application was described before the user test. New participants were recruited for each iteration to avoid the test being flawed due to prior knowledge and experience with the prototype.

"Controlled setting involving users" was used for the execution of the user test. This method means that the execution of the user testing was performed one by one in a controlled environment, and influence from others or distractions was therefore reduced (Roger et al., 2015). The controlled environment varied from test to test, but it was always a private room. "Controlled setting involving users" also allows for testing of a prototype that is not fully interactive as it includes a person monitoring and specific tasks. Such user testing can help determine if the interface is usable for what it is intended to be used for (Roger et al., 2015). The tests consisted of some background questions, a set of tasks, and a small semi-structured interview.

First, they were asked some background questions, without it being personally identifiable data. This may help put the results and feedback from the tests into perspective.

1. What is your age?
2. What is your gender?
3. Do you have any special diet?
    a. If yes, what diet?

After the background questions, they were given six tasks. It was emphasized that the test was not to test the participant, but rather the interface. It was important that the participants did not feel like they were being tested. The tasks were created to look realistic in terms of the purpose of the application. It was also kept in mind that the task should not be shaped in a way that guided the user and thus would remove the realistic aspect of the task. For example, “click on the beyond burger card to see more information” rather than “View more information about the beyond burger”. This allows them to navigate the app themselves and give better feedback on how intuitive the interface is. The six tasks were:

1. Go to plant-based burgers
2. View more information about the beyond burger
3. Look at nutrition values for beyond burger
4. Sort by lowest to highest energy (kj)
5. Choose a minimum and maximum value for energy (kj)
6. Show the products in a table form

The participants were encouraged to think out loud while performing the tasks. This allows for a better understanding of what the participants are thinking when interacting with the interface. It is however important to acknowledge that this may distract the user and they may use slightly more time (Lazar et al., 2017). Time was however not measured as this was not an issue for these tests.

Both participants’ actions and what they said were included in the notes. Looking at how they interacted with the interface, what they said, and how many clicks they used before getting to the right page were taken into consideration. This revealed a lot about their experience with the interface and its usability.

After the tasks were finished, a semi-structured interview was executed. If follow-up questions or clarification were needed, questions were added.

1. Is there anything you found difficult?
2. Is there anything we should add, remove, or change?
3. On a scale of one to five, where one is “not at all” and ten is “perfect”, how intuitive, and easily do you think it was to use the application?

For the last user test, the semi-structured interview had a stronger focus on how the app would affect participants' habits toward a healthier diet. Therefore, they were asked questions regarding how they would use it and what products they would choose given various scenarios (see Third iteration of user testing).

## 3.5 Analyzing the data - MoSCoW

For analyzing the feedback, the MoSCoW method was used. "MoSCoW is a prioritization technique for helping to understand and manage priorities." ("MOSCOW PRIORITISATION", 2022). The letters in "MoSCoW" represent the four prioritizing groups (Ahmad et al., 2017):

1. **M**ust have: These features must be included for the project to be considered successful.
2. **S**hould have: These features are important and shall be included if possible.
3. **C**ould have: These features are "nice to have" and can be included if possible with little cost and effort.
4. **W**on't have this time: Features that will not be implemented this time due to time, budget, or scope.

After conducting questionnaires, user testing, and interviews, the notes included a lot of important feedback that needed structure. For each iteration, a process of going through the notes and extracting and grouping feedback was done. If something was repeated, a number that represented how many times it was repeated was in parentheses. An example is "the text on this page is too small. (2)" or "two participants struggled to find the filter button". These would then be moved into the MoSCoW prioritizing groups were the following were taken into consideration:

- Time and scope
- Severeness and consequence of feedback
- Was it repeated by other participants?
- Budget

The feedback was placed into a table, containing the prioritization groups. The table was subject to change as work got done and more feedback was collected.

*Table 3.1: Table with the MoSCoW prioritization groups.*

| **M**ust have | **S**hould have | **C**ould have | **W**on't have this time |
|---|---|---|---|
| | | | |

# 4. Results

The results section consists of requirement specifications and three iterations of design and redesign of an application prototype. When the requirements were set, the development of the application prototype started. In the first iteration, sketches were made based on the requirements, which were then implemented into Figma as an interactive prototype that got tested on users. The second and third iterations consisted of redesign based on user testing and more user testing. In total, three prototypes were created and tested on users.

## 4.1 Requirements

Requirements were specified through analyzing data from a questionnaire while also looking at the literature review. The questionnaire allowed for a better understanding of what the application prototype should include. The literature review revealed features that might be better not included but also features that should be included. Based on this, functional and non-functional requirements were established (see Requirement Specification).

### 4.1.1 Gathering data – Questionnaire

There was diversity amongst the 37 participants. Their age ranged from 14 to 54 years old, with almost close to equal distribution of males and females. The participants were from eight different countries, but slightly more from Norway and France. They had various levels of education, but most had higher education.

The participants were asked if they already had any special diet. They were given some options, including “other”, where they could write something themselves. Most of the users answered that they do not have any specific diet. Some, 13.5%, of the participants considered themselves to be vegetarian. However, when later asked “how often do you eat plant-based meals?”, no one answered “never” (Figure 4.1). The second most popular response was “daily”, which 27% of the participants

answered. 29.7% answered “occasionally”, which was the most popular answer. All the participants already ate plant-based food products to some extent.

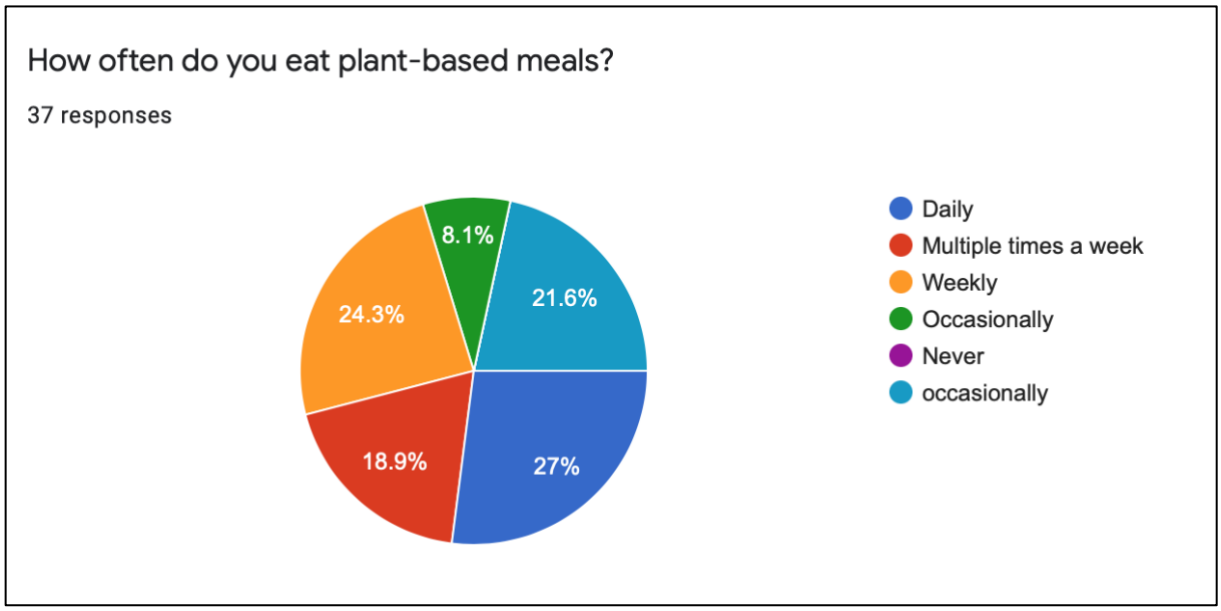



*Figure 4.1: Pie chart visualizing the distribution to answers for the question "How often do you eat plant-based meals?".*

The participants were asked what the reason for their diet is (Figure 4.2). Here most people answered “health”. People seem to be interested in eating healthy. They were also asked how concerned they were about eating healthy (Figure 4.3). Here most people, 37.8%, answered “4” on a scale of “1” to “5”, where “1” is “Not at all” and “5” is “Very concerned”. The second most popular response was “5”, very concerned. Only five participants answered below “3”.

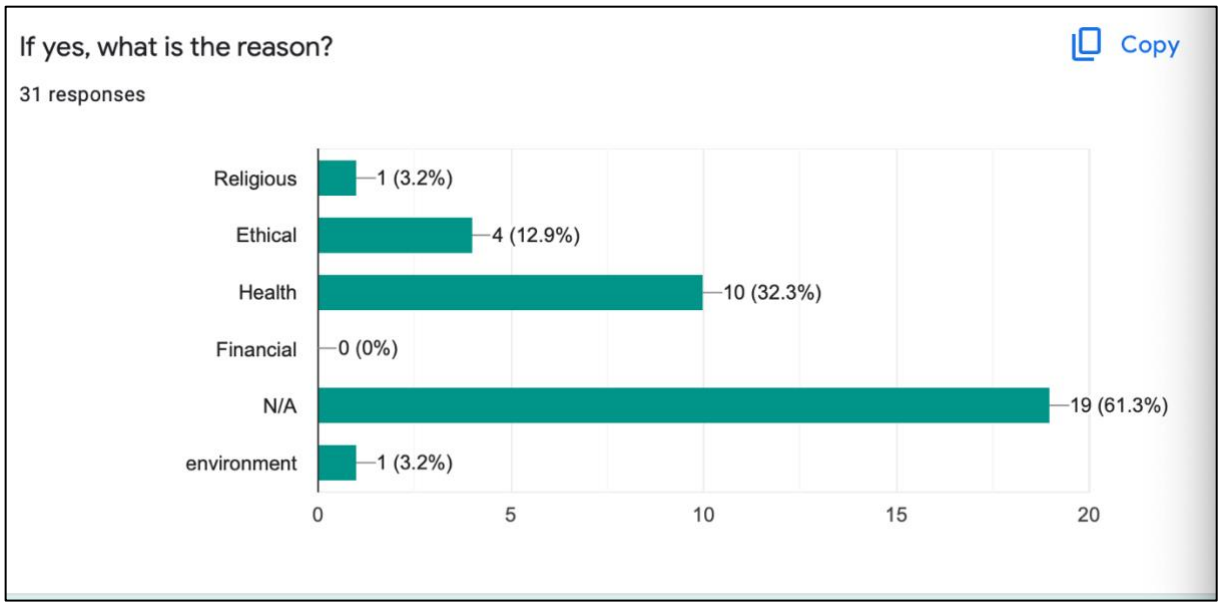



*Figure 4.2: Bar chart visualizing the distribution of answers for the question "If yes, what is the reason?".*

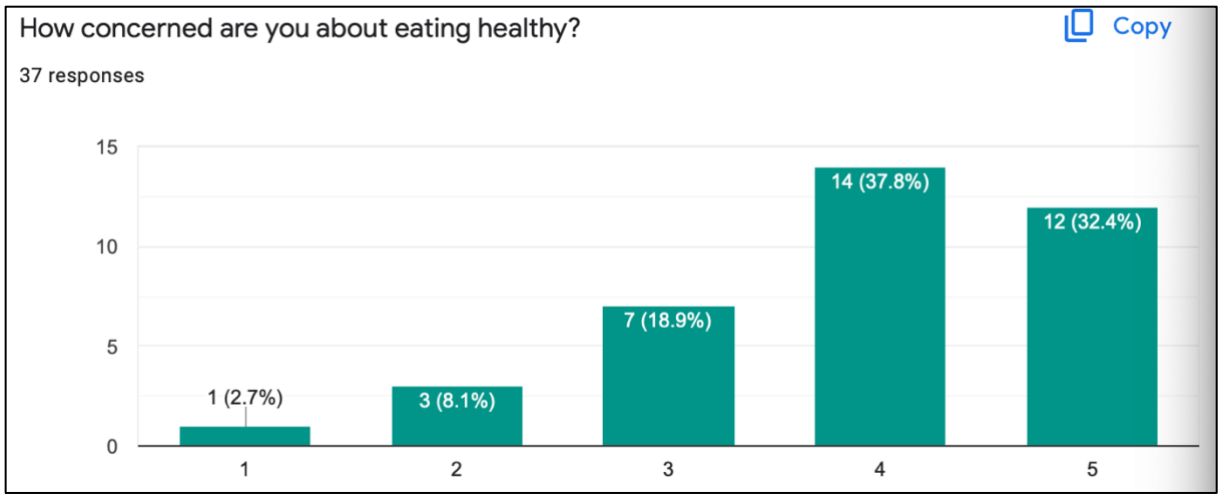



*Figure 4.3: Bar chart visualizing the distribution of answers to the question "How concerned are you about eating healthy?".*

The participants were asked about their level of knowledge about what is in plant-based products (Figure 4.4). Although many of them seem to eat plant-based products relatively often, the knowledge seems to be somewhat low. Again, they were asked to give a rating from “1” (Very low) to “5” (Very high). 73% answered “1”, “2”, or “3”. When asked “Do you think there is a lack of easily accessible and comparable information about the nutrition of plant-based food products?” the answers complemented the knowledge about what is in plant-based food products.

Only three people out of 37 answered “1” (Not at all) or “2”. The rest of the participants, 91.9%, answered “3”, “4”, or “5” (Definitively). 29.7% answered, “5” (definitively). This may imply that there is a lack of easily accessible and comparable information about the nutrition of plant-based food products to some extent.

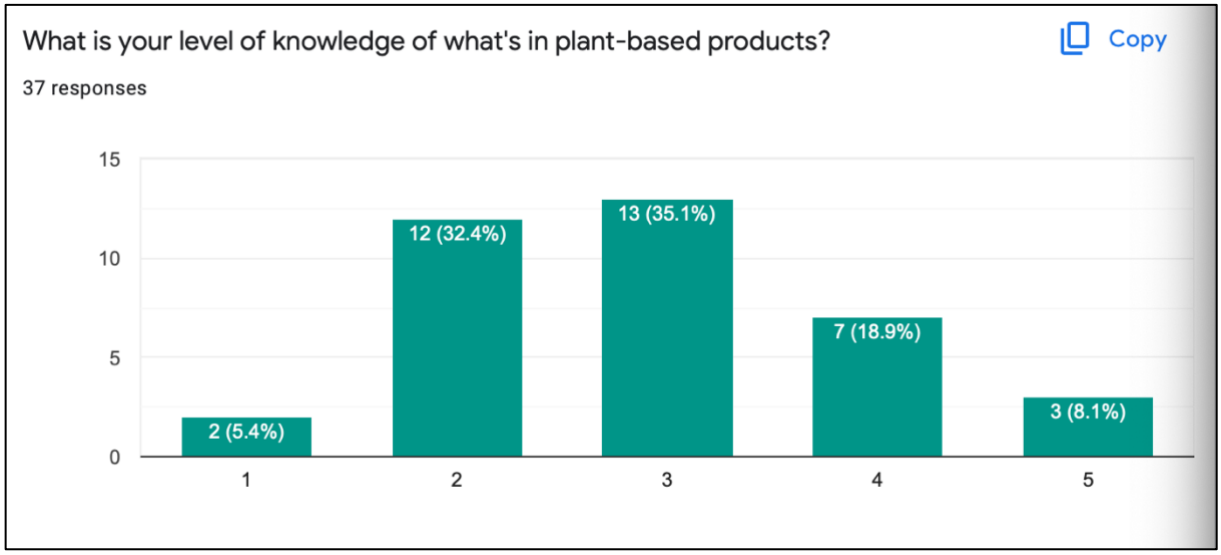



*Figure 4.4: Bar chart visualizing the distribution of answers to the question "What is your level of knowledge of what is in plant-based products?".*

Then they were asked, “Do you think a mobile app where you can access and compare plant-based food products will help you choose healthier products?” (Figure 4.5). Most of the participants were positive to such an app. Only three of the participants answered, “1” and “2” on a scale of “1” (Not at all) to “5” (Definitively). 15 participants answered “5”. This may imply that there is an interest in such an app.

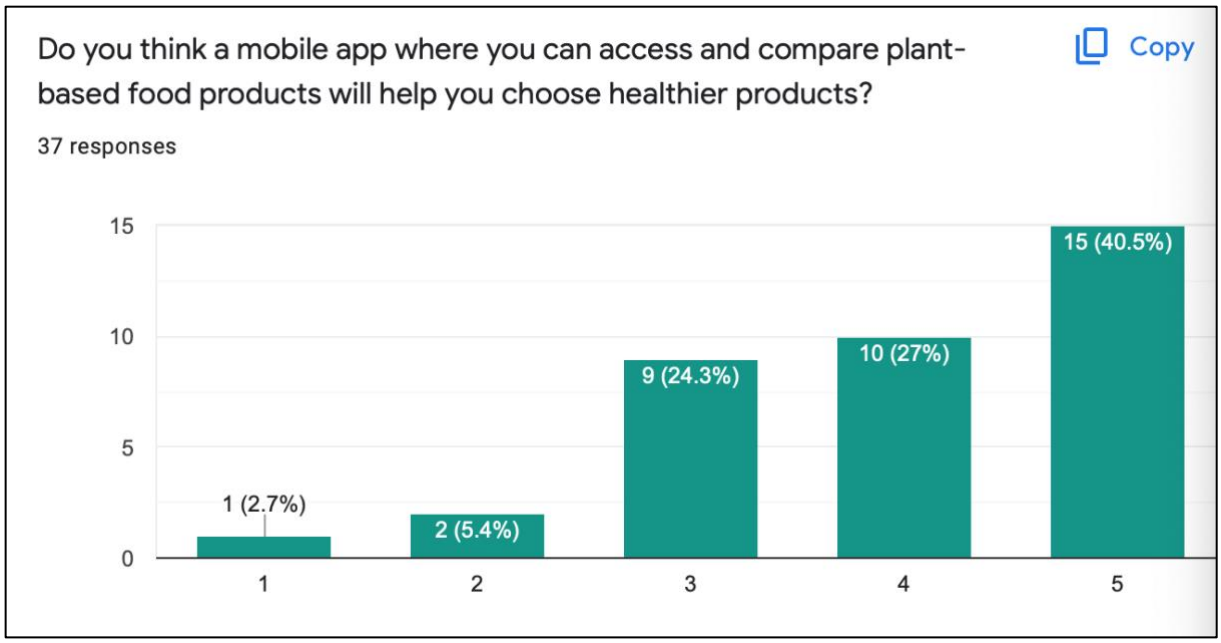



*Figure 4.5: Bar chart visualizing the distribution of answers to the question "Do you think a mobile app where you can access and compare plant-based food products will help you choose healthier products?".*

They were also asked to give a rating of “1” (Not at all) to “5” (Much more) on how much more plant-based meals they thought they would eat if they had such an app (Figure 4.6). The responses appear to be split, but some of the participants may not believe they will consume much more if they already eat solely or largely plant-based foods. However, “4” had the highest distribution of answers, which may imply that they think such an app could help them eat more plant-based.

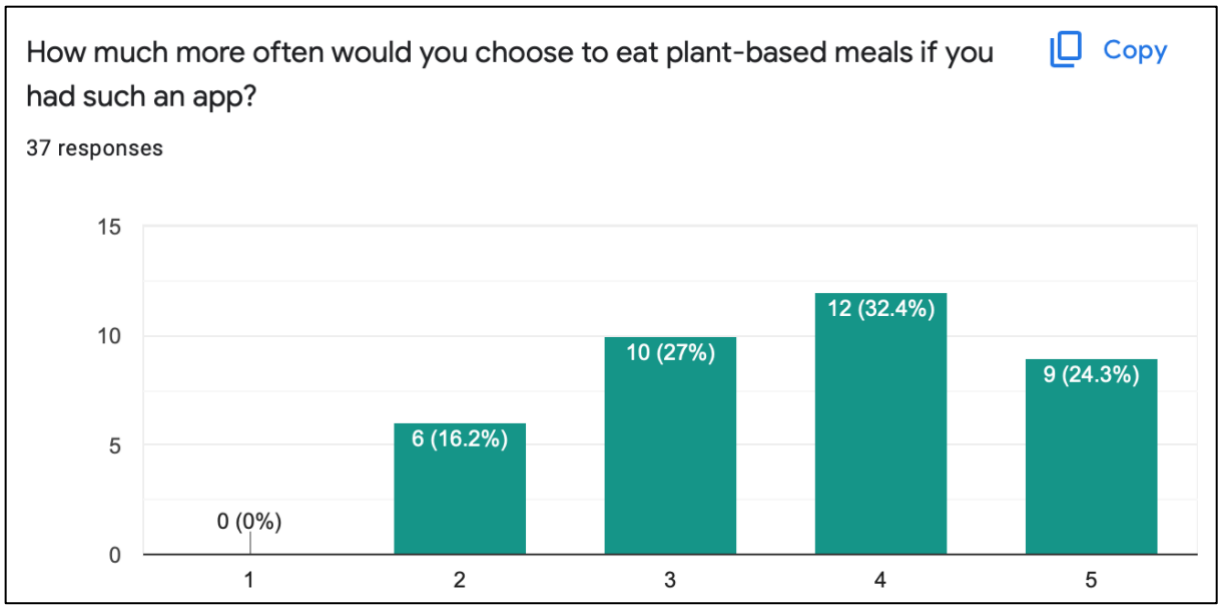



*Figure 4.6: Bar chart visualizing the distribution of answers to the question "How much more often would you choose to eat plant-based meals if you had such an app?".*

Due to convenience sampling, 40.5% of the participants in the questionnaire lived in Norway. This population group was thus slightly overrepresented in the questionnaire. Questions with answers on a linear scale of “1” to “5” (question 9, 10, 11, 12, and 13) were therefore made comparable for respondents living in Norway versus other countries. The following questions, with question number from the questionnaire, is represented in Figure 4.7:

8. How concerned are you about eating healthy?
9. What is your level of knowledge of what is in plant-based food products?
10. Do you think there is a lack of easily accessible and comparable information about the nutrition of plant-based food products?
11. Do you think a mobile application where you can access and compare plant-based food products will help you choose healthier food products?
12. How much more often would you choose to eat plant-based meals if you had such an application?

These answers were put into google sheets and made into a bar chart where each question number has a red pole and a blue pole. The red pole represents the

mean answer for participants living in Norway and the blue pole represents the mean answer for participants living in other countries (Figure 4.7).

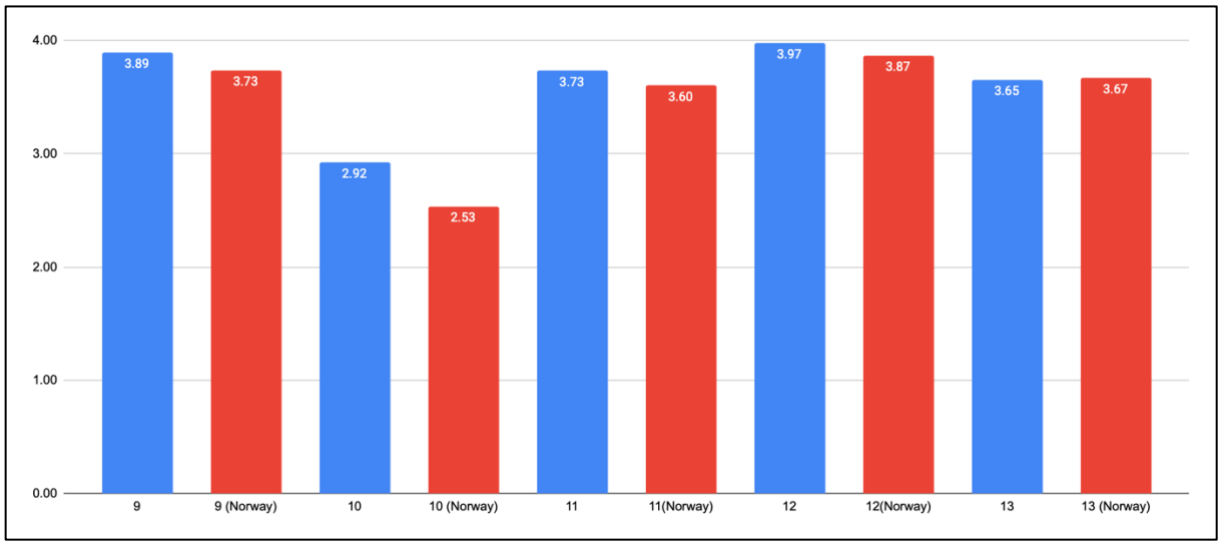



*Figure 4.7: Bar chart visualizing the mean distribution of answers from participants living in Norway (red pole) versus participants living in other countries (blue) for questions 9, 10, 11, 12, and 13.*

The answers are relatively similar regardless of living in Norway or other countries. However, there is a slightly noticeable difference in the level of knowledge of what is in plant-based food products (question 10). Answers of participants living in Norway had a mean of 2.53, while the rest had a mean of 2.92. This difference is not significant, but could suggest that people in Norway believe they know less about the subject.

The final question was if the participants had any features that they wanted in a mobile application for accessing and comparing plant-based products. This question was not mandatory to answer but got various answers which needed to be taken into consecration. Due to scope and time, all of these were not implemented, but may be future work.

The participants answered:

- Easy recipes / Tells you what to buy
- Country and origin

- Ingredients
- Recipes for the products
- Search for non-plant-based food products you are craving and get a recommended similar plant-based food product.
- Substitutes
- Which product has the best taste

The following section, Requirement Specification, analyzes and groups the feedback from the questionnaire and forms them into requirements.

### 4.1.2 Requirement Specification

Requirements for the application were formed based on literature review, the questionnaire with potential users, and universal design principles and standards.

For the feedback of the questionnaire, the MoSCoW method was used to prioritize the features:

*Table 4.1: MoSCoW table with feedback from the questionnaire places into the prioritization groups: Must have, Should have, Could have, and Won't have this time.*

| **M**ust have | **S**hould have | **C**ould have | **W**on’t have this time |
|---|---|---|---|
| Compare products | Recommend plant-based food products when users want non-plant-based food products | Country and origin or product | Recipes |
| Easy access to information about products | | | Taste |
| Ingredients | | | |

Easy access to information about plant-based food products, comparing them, and their ingredients is the basis of the idea and is thus in the “Must have” section. The analysis of the questionnaire answers found there to be a need for these features.

Recommending plant-based products when a user is looking for a meat product was put in the “should have” category. This feature supports the idea of promoting healthier plant-based food products over meat products. However, the prototype is considered successful without this feature, and it is therefore not of highest priority, but should be implemented.

Country and origin of a product could be interesting to implement, but slightly out of scope and time. Thus, this feature was put in the “could have” section. It will be implemented if there is time and not too much effort is required.

Recipes and taste of a product will not be implemented this time. These are features that may be interesting but is outside of the scope but can however be implemented in future work.

The application must satisfy the following requirements:

**Functional:**

- Show product name and nutrition values
- Show ingredients in product
- Show picture of product
- Sort products ascending or descending based on a nutrition value
- Filter based on minimum and maximum values for nutrition values
- Have a search function
- Compare products based on nutrition value

**Non-functional:**

- User friendly

- Logical and intuitive
- Support IOS
- System scalability
- Support screen reader
- Have alternative text for pictures and symbols
- Text and images of text must have a contrast ratio of at least 4.5:1
- Large text must have a contrast ratio of at least 3:1

These requirements must be implemented in the prototype. The limitations of Figma exclude some requirements, such as scalability, screen reader, and language. This is discussed in the Limitations and Future Work sections.

## 4.2 First iteration

For the first design iteration, the requirements were implemented. After sketching on paper (Figure 4.8), a high-fidelity prototype was implemented in Figma. green colors were chosen as it is commonly related to health and therefor was a suitable color for this app that will promote plant-based products and a healthier diet. The prototype was interactive so it could be tested by users. It was created with Norwegian language on an iPhone 11, but it is emphasized how important it is for it to be available in more languages and devices in the future.

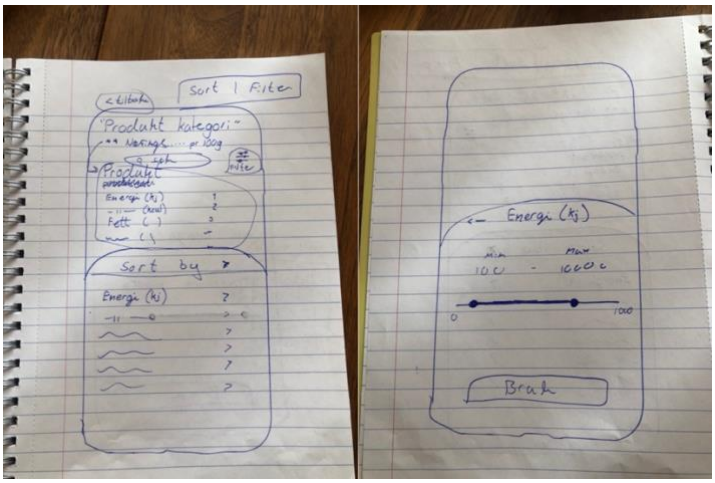



*Figure 4.8: Some of the sketches made before the first prototype.*

The prototype was made interactive for the category “plantebaserte burgere” (plant-based burgers) with information on the “beyond burger”, and filters for “energi (kj)”. These are representative features as other products and filters would look similar. The first prototype includes the following pages represented in a simple flowchart below (Figure 4.9).

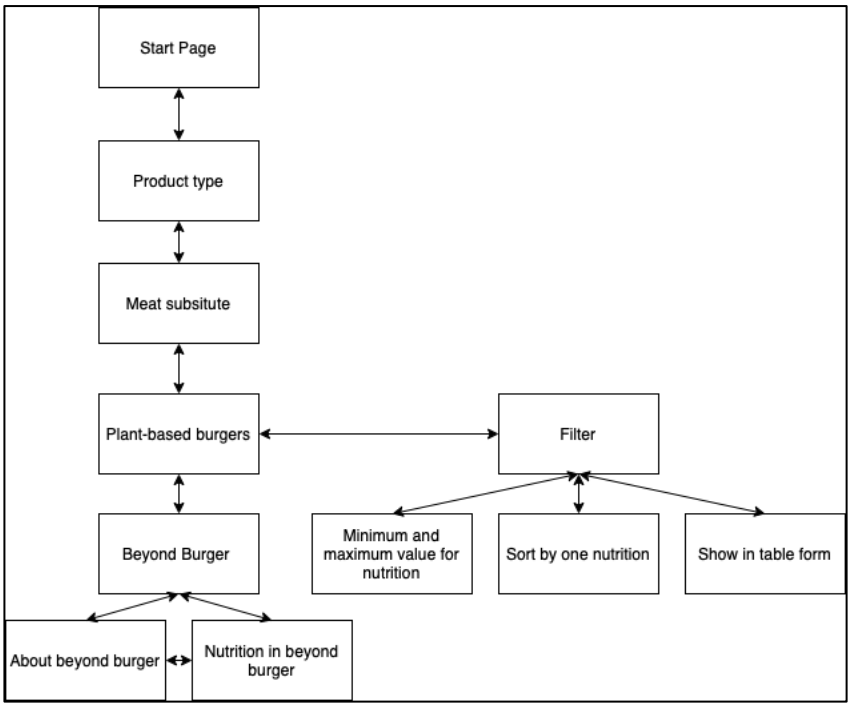
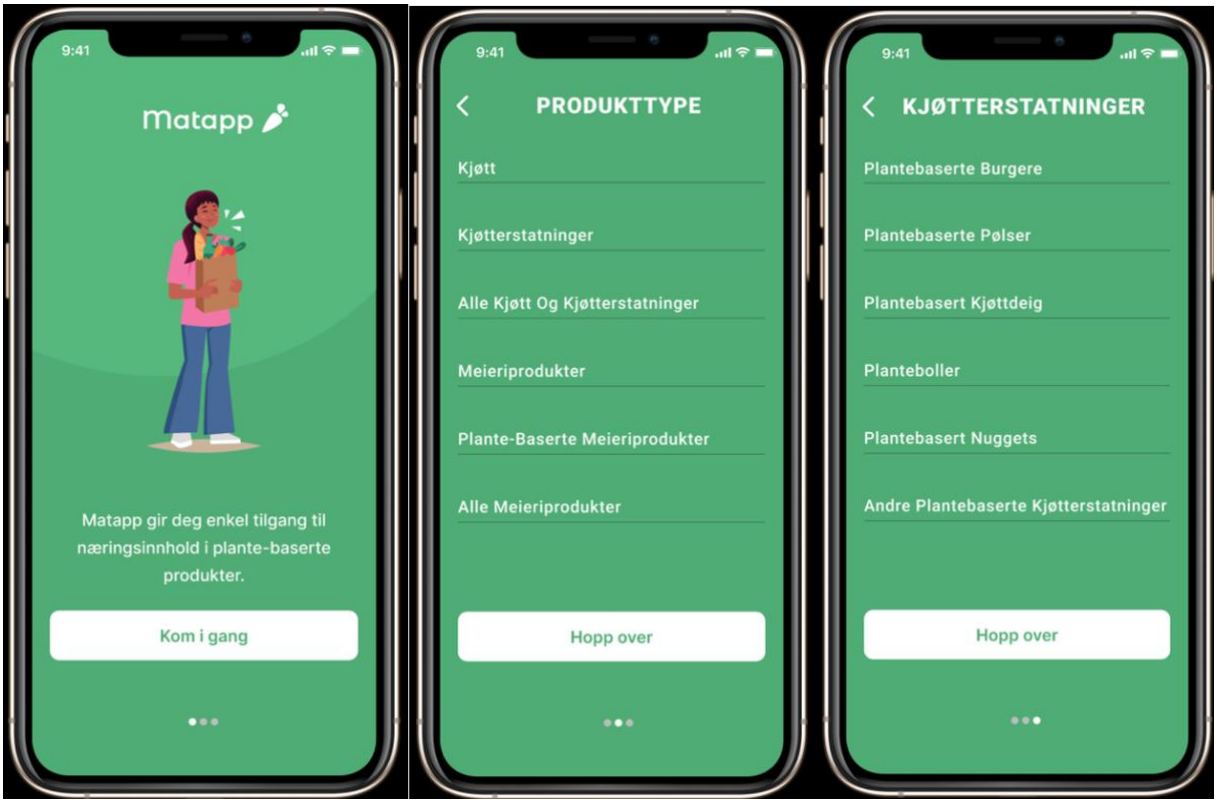



*Figure 4.9: Flowchart representing the flow of the first prototype application.*

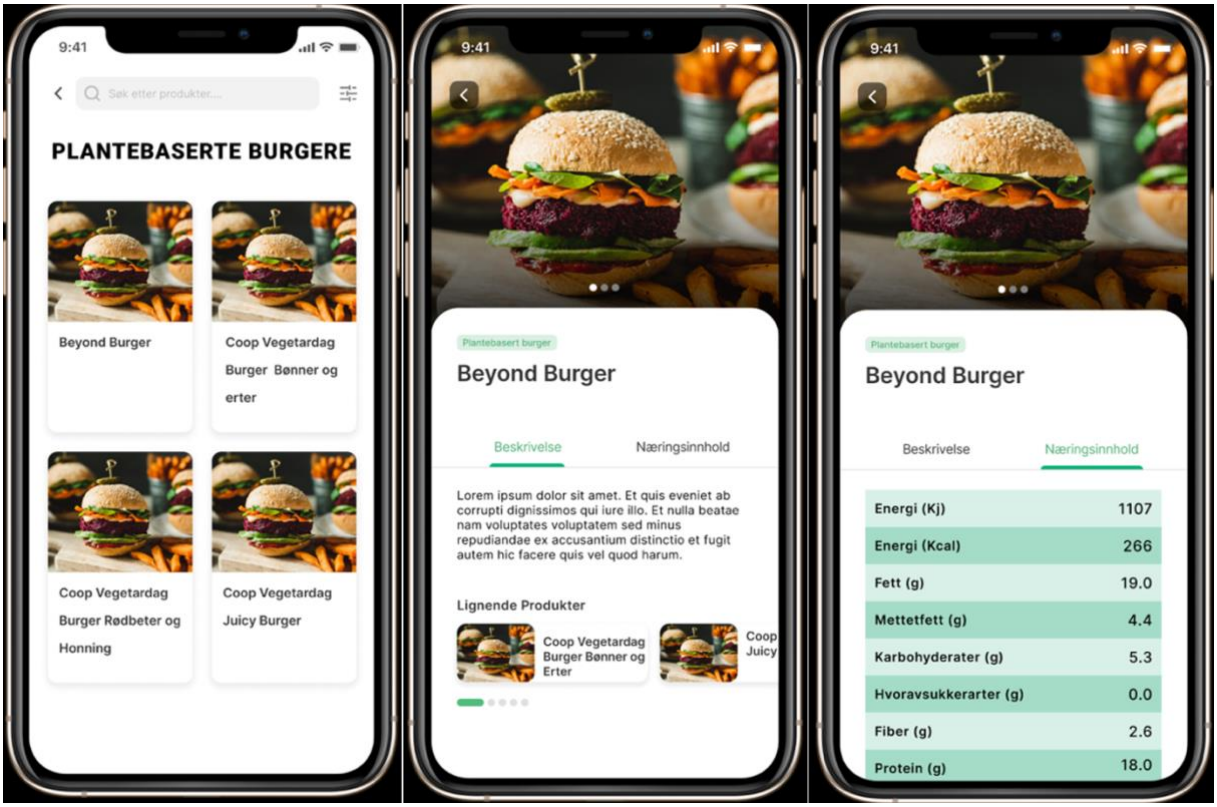
The first thing a user will see is the onboarding pages. First, there is a welcome page with a short description of the application (Figure 4.10, Picture A), then one can choose a product type or choose to skip and see all products (Figure 4.10, Picture B). Within a product type, the user can choose a sub-category or see all products within that product type (Figure 4.10, Picture C).




A B C

*Figure 4.10: Group of screenshotsshowing the onboarding pages (A, B, and C) for the first prototype. A shows the welcome page, B shows the page for choosing product type, and C showsthe page for categories under the product type "Kjøtterstatninger" (meat subsitutes)*

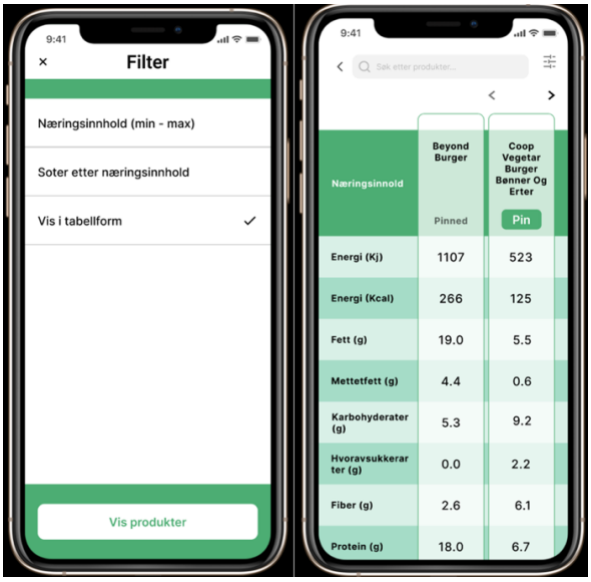
After choosing a category, products within that category will be displayed (Figure 4.11, Picture A). The products are displayed with the product's name and a picture. The picture in this version of the prototype is a picture from unplashed.com, a website with pictures free to use for any project, of a plant-based burger. It was unclear whether pictures of the products from the producer's website would be allowed to use in the prototype. These pictures were thus filled in here for this prototype. The user can then click on a product to see more information. The product page gives a description and nutritional values of the product (Figure 4.11, Picture B and C). The table with nutrition values was filled in, while the description was not completed in this version. For the first prototype, the focus was on getting it ready to be tested rather than filling out every aspect of it.




A B C

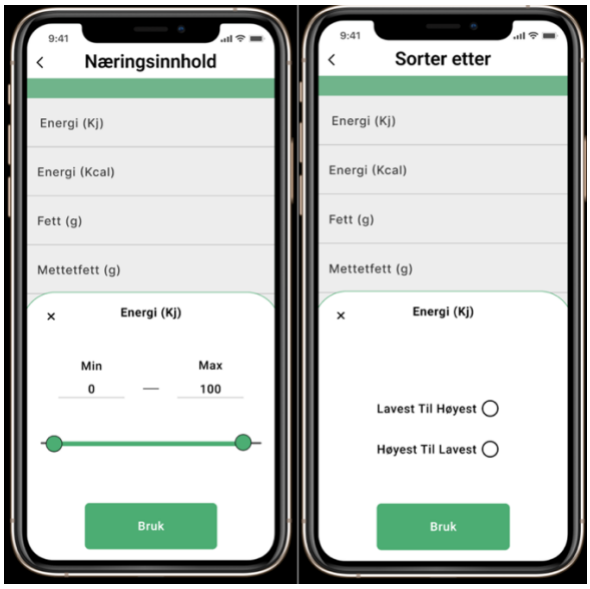
Figure 4.11: Group of pictures A, B, and C. A shows the page for viewing products, B shows the product page for beyond burger with description, C shows the product page for beyond burger with the nutrition values.

The user can access filters by clicking the “filter symbol” in the top right corner displayed on picture A in Figure 4.11. The filter page (Figure 4.12, Picture A) allows the user to get the desired range of products displayed. Here they can choose a minimum and maximum for the different nutrition (Figure 4.13, Picture A), sort by nutrition (Figure 4.13, Picture B), or choose to display the products in a table. Showing products in a table displays two products and their nutrition to be compared (Figure 4.12, Picture B). The user can pin the preferred product and scroll through other products and compare it to the pinned product.




A B

*Figure 4.12: Group of picture A and B. Picture A shows the filter page, and Picture B shows the page for viewing products after the user has selected "vis i tabellform" (show as table) in the filter.*




A B

*Figure 4.13: Group of picture A and B. Picture A shows the filter page for minimum and maximum value for nutrition, Picture B shows the filter page for sorting by nutrition from lowest to highest or highets to lowest.*

### 4.2.1 First iteration of user testing

After the first version of the prototype was finished, user testing was executed as described in the methodology section.

The user testing included four participants:

- Participant 1: 52 years old, male, no specific diet.
- Participant 2: 45 years old, female, no specific diet.
- Participant 3: 25 years old, female, pescatarian.
- Participant 4: 25 years old, female, no specific diet.

For the first task, they were asked to “Go to plant-based burgers” (See section on user test in methodology section for all tasks), some of the participants were a bit confused. This meant that they had to click “kom i gang” (get started) on the welcome page (Figure 4.10, Picture A), then click “kjøtterstatninger” (meat substitutes) as product type (Figure 4.10, Picture B), and then “plantebaserte burgere” (Plant-based burgers) as the subcategory (Figure 4.10, Picture C). As many of them seemed to hesitate during the performance of the tasks, they were asked about it in the interview after all tasks were done. They answered that they were looking for “plant-based burger” first, before they realized it was a category under a product type. When they realized that, they were quick to guess it was under “kjøtterstatninger” (Meat substitutes). They were unsure of which product type plant-based burgers would be under and thus took some time to think. They said that they were drawn toward the big white button on the page. No one did however click it, but Participant 3 said, “if it was just a normal app I had downloaded, I would have clicked it.” This may imply that they were more conscious of where they were clicking even though they were told that it was not meant to test them, but the interface. They also suggested that these categories should be more accessible and easier to find on the products page.

For the second task “view more information about the beyond burger”, all the participants were relatively quick to click the “beyond burger card” and get more information about the burger. From there they also found the nutrition values (the third task) easily. However, the older participants seemed to struggle a little bit with

the little label that said “plantebasert burger”. This was confirmed in the interview after the test.

For the fourth task, they were asked to sort the products by “energi (kj)”. Most participants found this easily, but many said that did not know what “energi (kj)” meant. They said that the “filter” symbol is intuitive. The next task, “choose a minimum and maximum value for energi (kj)” seemed to be done quickly and easily by the participants. More nutrition information may be necessary.

For the last task, they were asked to “show the products in a table form”. They already knew where to find the filter and quickly found out how to show it in table form.

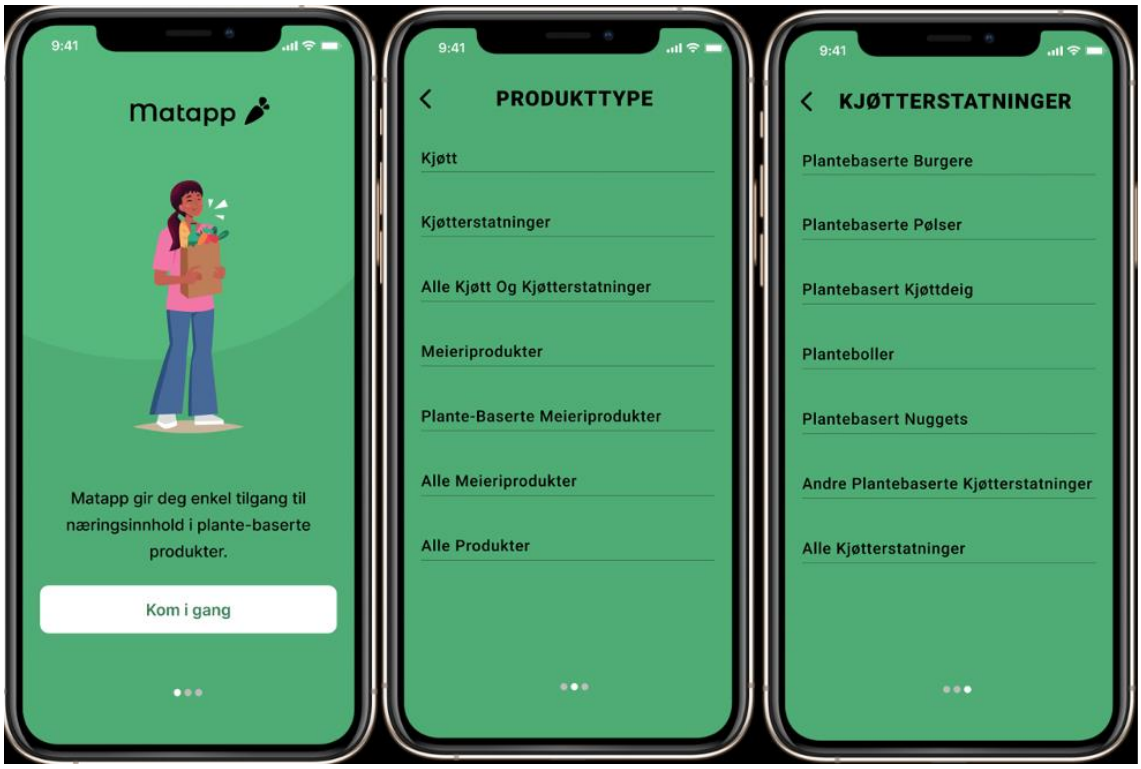
During the semi-structured interviews, they were asked how intuitive they experienced the application. They were asked to give a rating on a scale of “1” (Not at all) to “5” (Perfect). All participants answered “3”, except Participant 3, who answered “4”. The participants seem to overall have found the prototype application somewhat intuitive, but there is room for improvement.

## 4.3 Second iteration

For the second iteration, changes were made based on the feedback from the user testing in the first iteration. A simple summary of the changes for the second prototype is as follows:

- Higher contrast several places in the prototype.
    - on the “plantebasert burger” (plant-based burger) label.
    - the “beskrivelse” (description) and “næringsinnhold” (nutrition values).
- Removed the button on the onboarding pages.
    - And some places in the filter.
- Specified that the nutrition is pr 100 g.
- Added categories to the filter for easier access.
- Changed the pictures.
- Protein was mentioned twice.

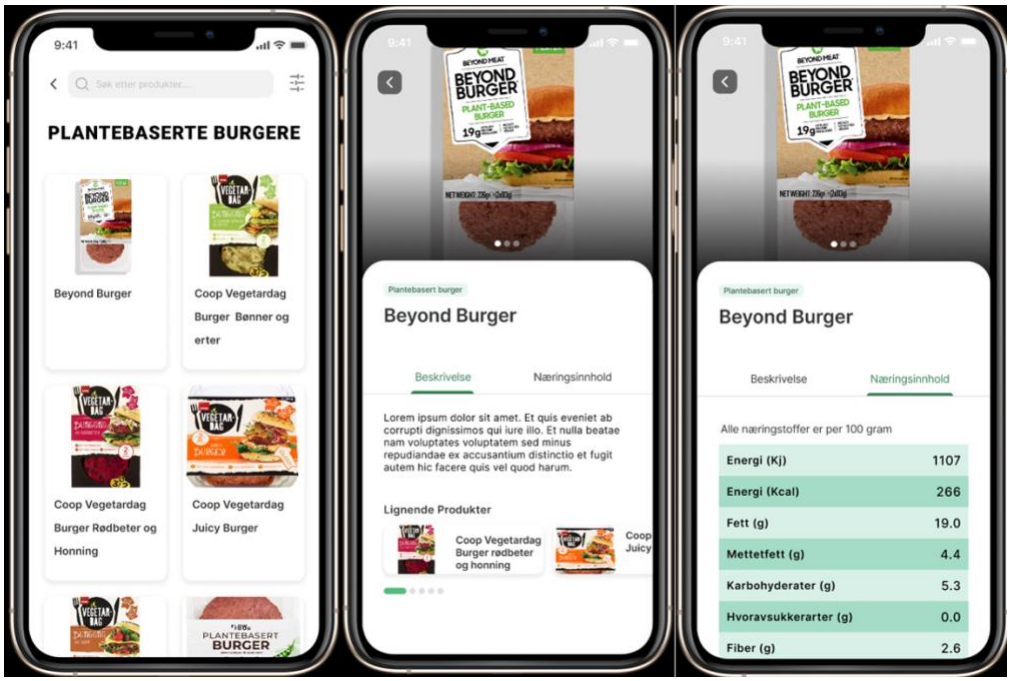
On the three onboarding pages (Figure 4.10) the text color was changed and the big “hopp over” (skip) button was removed (Figure 4.14). The white text on the green background was found to be of too low contrast according to the WCAG guidelines. It was therefore changed to black text, which has a contrast ratio of 7.53:1 and thus fulfills the requirement of at least 4.5:1. The “hopp over” (skip) button was removed as users felt drawn toward it and wanted to click it rather than read the categories. Some did not understand why it was there. “alle produkter” (all products) and “alle kjøtterstaninger” (all meat substitutes) were however added as a way of accessing all product types or all products within a product type.




A B C

*Figure 4.14: Group of picturs showing the oboarding pages with changes.*

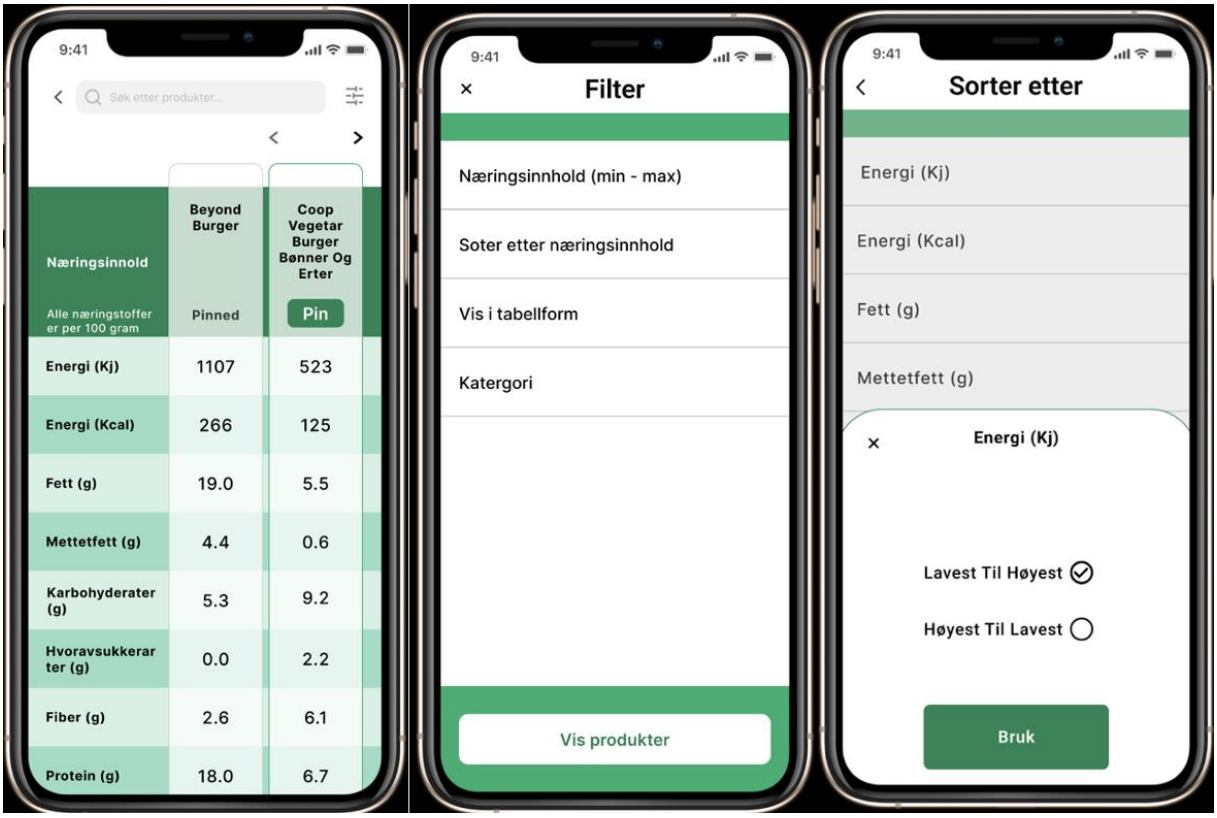
Furthermore, the pictures on the product page were replaced with actual pictures of the products (Figure 4.15). The first prototype also had pictures, but it was a picture from unsplashed.com, which is a website with free pictures that can be used for any project. Feedback from the user test suggested that the pictures were well liked. Figma does not allow alternative text, but future work and development of the application should include alternative text for the pictures.




A B C

*Figure 4.15: Group of pictures showing the page for viewing product and the product page for Beyond Burger. The pictures show the changes made from the first prototype.*

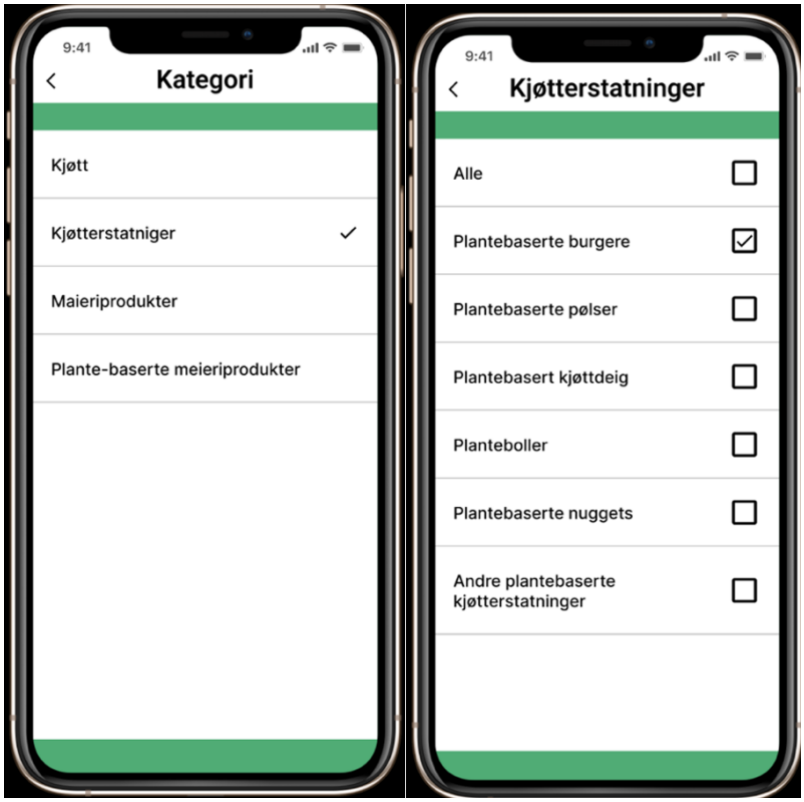
The contrast ratio was found to be low in several places in the first prototype. On the product page (Figure 4.11, Picture B and C), the green text was found to be too low, and thus increased to fit the requirement of 4.5:1 (Figure 4.15, Picture B and C). When showing products in table form, the green background behind the titles were changed to fit the contrast ratio requirement (Figure 4.16, Picture A). This was also the case for some of the buttons which had the same background color with white text on top of it (Figure 4.16, Picture C).




A B C

*Figure 4.16: Group of pictures A, B, and C. A shows the page for viewing product in table form, B shows the filter page, C shows the filter for sorting by a nutrition. This version of the prototype has higher contrast.*

Some participants thought it was a bit difficult to access the product categories. Categories can therefore now be accessed on the filter page (Figure 4.16, Picture B). Here, users can choose their desired product type and subcategories with check boxes (Figure 4.17).




A B

*Figure 4.17: Group of pictures A and B, showing the new category pages one can access from the filter page.*

Some users said that they did not know much about nutrition values. More nutrition information was however not implemented. Providing information about all the nutrition values may take time and make the app more complex outside the scope. The focus was on providing nutritional information without any commentary on what is or is not healthy. Some sort of objective information may be implemented in the future.

### 4.3.1 Second iteration of user testing

User testing was performed on the second version of the prototype with the same tasks as previous (see User testing), but with a new set of users:

- Participant 5: 23 years old, female, no specific diet.
- Participant 6: 18 years old, female, vegetarian.
- Participant 7: 24 years old, male, no specific diet.

- Participant 8: 24 years old, male, no specific diet.
- Participant 9: 26 years old, male, no specific diet.

When finding the plant-based burger, it seemed to be an easier task this time. This set of user testing included mostly younger participants than last time. Even though only one of them was vegetarian, they all seemed to click the “kjøtterstatninger” (meat substitutes) faster than the previous participants. This may be because they are more familiar with such terms, but it can also be due to the changes. The removal of the “skip” button may have removed some confusion and the color of the text may have made it easier to read the text.

These participants also easily found more information about the “beyond burger”. This time none of the participants commented on the contrast of this page. Two participants asked what was going to be in the description as it currently is a fake text. When asked back what they would want, the answers were “price and ingredients” and “what it says on the back of the package”. Price may vary, but ingredients are available on the producer’s website and may be implemented. One participant did also mention that if the focus of the app is nutrition, then maybe that should be the landing page when clicking on the product.

A task regarding choosing categories was added to see how the new feature of choosing categories on the filter page was. This task was added before the other task involving interaction with the filter page. This way the users could not have seen the button for accessing categories already. Here three of the users went back to the onboarding pages, while two explored the filter and found it there. When asked after the test, all of them did however say that it was useful to have access to categories in both places.

The remaining tasks were concerning the filter features. The previous test did not reveal any difficulties regarding these tasks. These participants also found the features in the filter easy to use. Some of them said that they were familiar with the “filter” symbol as well as the filter options, and it was very intuitive.

Following the tasks, a semi-structured interview identified some potential difficulties. Participant 6 stated that comparing products was difficult. This can be due

to that the compare pages were not interactive. However, the participant suggested that some sort of select, and search method could be useful. Participant 9 suggested since the application´s goal is to provide simple access to nutrient values, it should be easier to see and compare the products nutrition values.

These users appeared to believe that this version of the prototype was more intuitive than the prior version of the prototype. Also, these users were asked to give a rating on a scale of “1” (Not at all) to “5” (Perfect). Here all the participants answered “4”, except for Participant 9, who answered “3”. The mean for this iteration was 3.8, while the mean for the previous iteration of user testing was 3.25. This may imply that the changes made in the prototype has made a positive impact on usability.

## 4.4 Third iteration

For the last and final version of the prototype application, changes were made based on user testing, but also quality check done by tutors. The tutors were given a link to the second version of the prototype and checked every aspect of it. As they are both professors and work within universal design, this gave more professional viewpoints and feedback on the prototype. They are however very close to this master thesis and might therefore be biased. An overview of the changes from the second version of the prototype is presented in the following changelog:

- Increased size of text.
    - “plantebasert burger” on product site.
    - The description on the product page.
    - “alle næringsstoffer er per 100 gram» was made shorter to «per 100 gram» and increased in size.
- Fixed some spelling errors.
- Inserted an actual description of the product from the producer’s website. References to websites used are included in the info page in the prototype.
- Included an about/info page with references to information used in the prototype, such as about products.

- The landing page when clicking on a product is nutrition value for that product rather than the description.

  The interactive version of the third prototype can be found here: https://www.figma.com/proto/CBClxKAjySH8mkLLD41zu7/Mat-app?node-id=351%3A1394&scaling=scale-down&page-id=0%3A1&starting-point-node-id=351%3A1394&show-proto-sidebar=1

The final prototype has two more pages than the first prototype had. During the second iteration, categories were added, and during this iteration, an information page was added. The final flow of the prototype application is illustrated below as a flowchart (Figure 4.18). The new pages, “Info page” and “Category”, are marked in green.

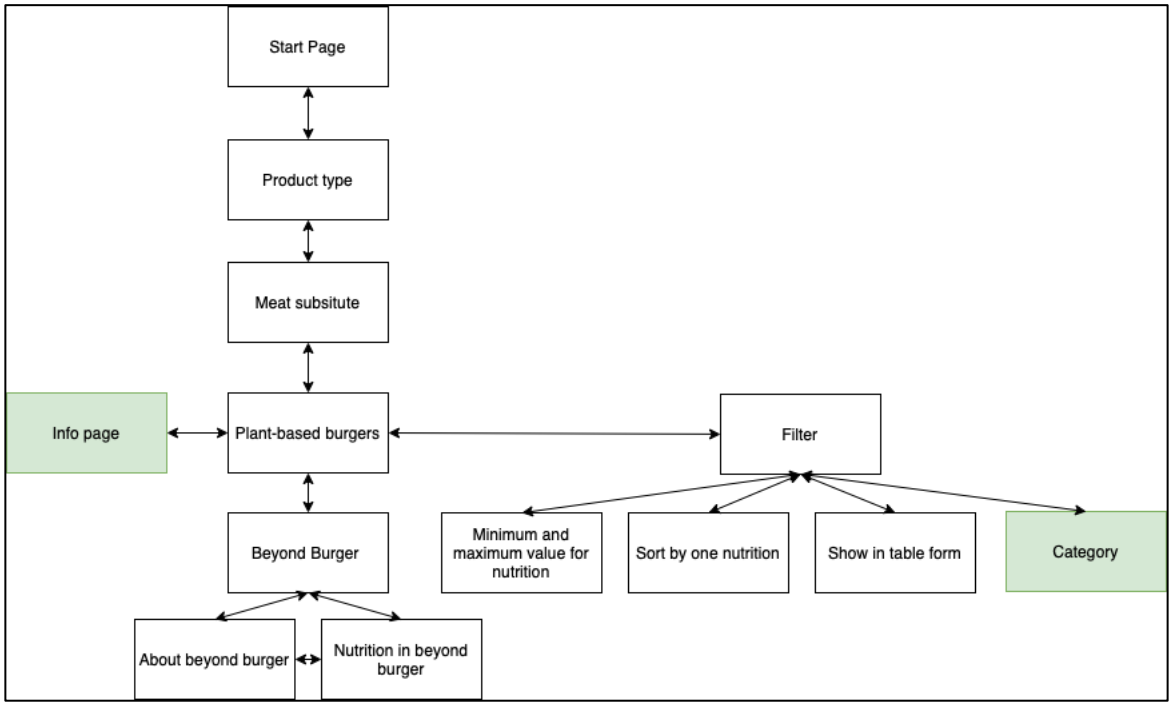



*Figure 4.18: Flowchart representing the flow of the last version of the prototype application.*

Feedback from the quality check said that an info page could be implemented into the prototype. Thus, a page with information about the application and references were added (Figure 4.19, Picture B). Here, the user can get a better understanding of the purpose of the application. They can access more information

about the research behind the application or the products mentioned in the prototype. The information page can be accessed through the question mark symbol in the top right corner when viewing products (Figure 4.19, Picture A). This question mark symbol was used as the info page can help users get access to more helpful information.


A B

*Figure 4.19: Group of picture A and B illustrating the changes made in this iteration. Picture A shows the page for viewing products, and Picture B shows the new information page.*

When clicking on a product, the user will now be presented with the nutrition values first. In the previous prototypes, the description would be presented first. Thus, the number of clicks needed to see nutrition values in the products is reduced by one click. This strengthens the main purpose of the application, which is to provide easy access to nutrition values in products.

A description of the products was implemented (Figure 4.20). Using the producer's website as a source, a description of the product, size in grams, and ingredients was added. As mentioned earlier, price was not added as it may vary from store to store. Country and origin of the product were not available on the websites and were therefore not added.


*Figure 4.20: Prototype 03 - Product page for Beyond Burger showing a description of the product. It includes a description, size in grams, and ingredients.*

### 4.4.1 Third iteration of user testing

For this iteration of user testing, the focus was on inspecting the research question and its sub-questions:

> **To what extent can a universally designed smartphone application where consumers can easily assess and compare the nutritional value of plant-based food products change people's behavior and mindset towards a healthier diet?**

**How can it help people make healthier decisions regarding their diet?**

**How can it help people be more aware of nutrition values in plant-based food products compared to meat products?**

Five users participated in this iteration of user testing:

- Participant 10: 21 years old, male, no specific diet.
- Participant 11: 51 years old, female, no specific diet.
- Participant 12: 52 years old, male, no specific diet.
- Participant 13: 24 years old, male, no specific diet.
- Participant 14: 19 years old, male, no specific diet.

The users performed the same tasks as in previous iterations, with one extra task regarding the new info page. They were asked to “see more information about the prototype application”. This was to see whether the new question mark symbol in the top right corner was intuitive enough. All the participants found the information page easy. All the participants clicked the question mark symbol first. All the participants were not satisfied with the information page. The simple text did not appear very pleasant. Others believed the page was fine for providing information. Some work on this page may be required for future work.

After the tasks, a semi-structured interview was conducted. Questions were added for this iteration to get a better idea of the effect the application might have on users. The following seven questions were added in addition to the previous three questions:

1. On a scale of one (not at all) to five (very much), how much do you care about eating healthy?
2. How often do you look at nutrition values? How familiar are you with the terms?
3. On a scale of one (not at all) to five (very much), do you think this app could increase your level of knowledge about nutrition values?

4. How often do you use dietary or health applications? What kind of applications? How do you use them?
5. *Shows Figure 29 through Figma mirror*. What do you think when you see this?
6. Would you use this app? How would you use it?
7. How do you think it would affect your decisions and eating habits?

For this last version of the prototype, the usability did not seem to increase. When the participants in this iteration of user testing were asked to give a rating for the usability, the average of 3.8 stayed the same as for the second iteration (Table 4.2). This may be due to minor changes from the second iteration.

*Table 4.2: Table showing the mean answer for how usable the participant thought the prototype was for each iteration.*

| **Iteration 01** | **Iteration 02** | **Iteration 03** |
|---|---|---|
| 3.25 | 3.8 | 3.8 |

The participants were asked how much they care about eating healthy to get an idea of what the participants already think about a healthy diet (question 1 in the list above). They gave a rating between “1” (not at all) to “5” (very much). Three of the participants answered three, while two answered four. They seemed to care to some extent, but they did not consider themselves to care “very much” (Figure 4.21).

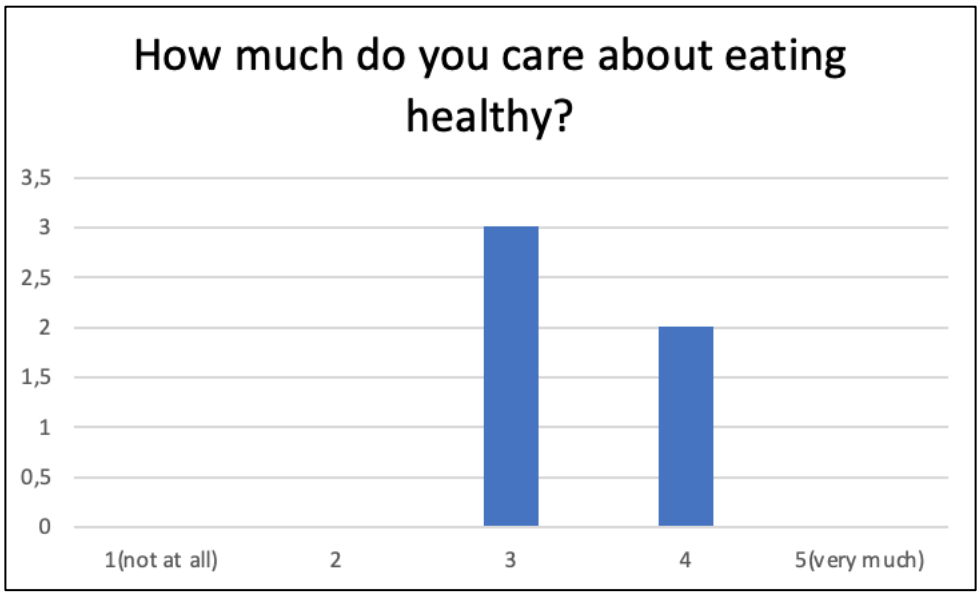



*Figure 4.21: Bar chart visualizing the distribution of answers to the question "How much do you care about eating healthy?"*

They were then asked how often they check nutrition values and how familiar they are with such terms. Some of the participants said that they did not look at it, but that they knew the meaning of some, or all the nutrition values used in this application. Some of them checked it sometimes, and Participant 13 said that he often tries to choose the healthier option, and thus checks the nutrition if it is a new product.

They were asked to what extent they think this application could help them gain more nutrition knowledge. Participant 13 answered “5” (very much), while the others answered “4”. However, all of them seem to think that this application could provide them with more knowledge of nutrition values.

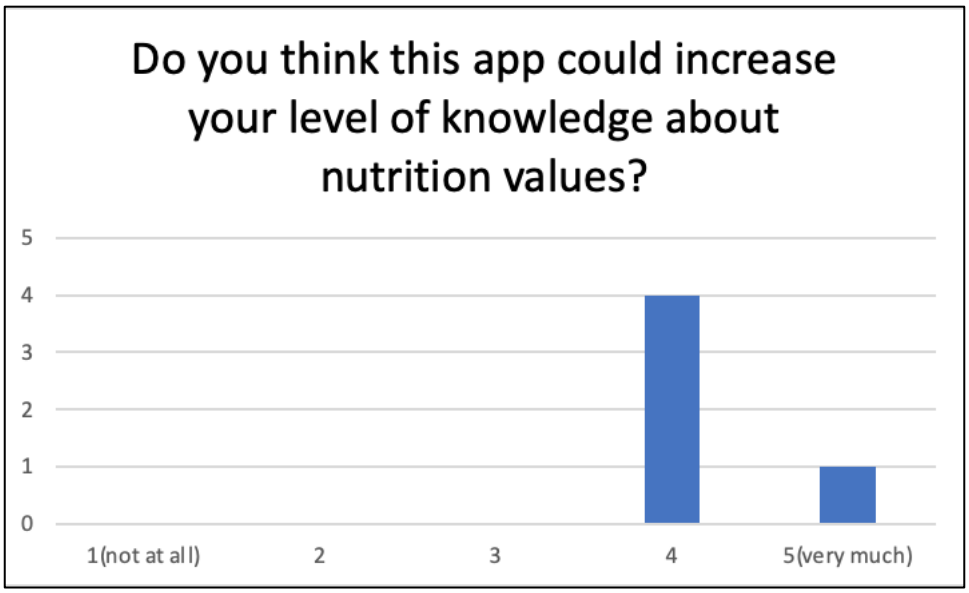



*Figure 4.22: Bar chart visualizing the distribution of answers for the question "Do you think this app could increase your level of knowledge about nutrition values?" on a scale of "1" (Not at all) to "5" (Very much).*

To get a perspective of the participant's previous experience with dietary or health applications, they were asked if, and what applications they already use. All of them used some sort of application related to health. Most of the applications mentioned were related to tracking workouts and movement, and statistics related to body fat and weight. However, none of the participants used any applications related to diet. This can still imply that they are used to applications that promote behavior change.

The participants were shown a page in the application that compared a meat burger, Gildeburger Classic, and a plant-based burger, Coop Vegetar Burger Bønner og Erter (Figure 4.23). They were asked what they thought when they saw it. Most of the participants noticed the fat and the protein. The plant-based burger had significantly lower fat, but also significantly lower protein. Most of them pointed out that the choice would probably be based on whether one prioritizes protein or less fat. Some of them seemed to be surprised by the fat content in the meat burger and said that maybe they should consider a plant-based burger next time. Most of them did however point out that the plant-based burger made of beans and peas, did not sound very appealing in regards of taste.

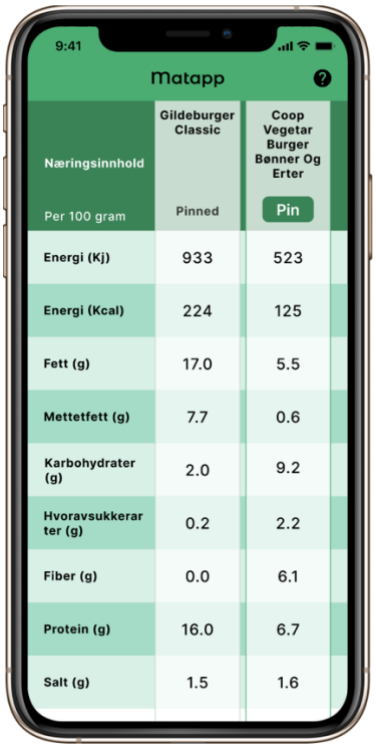



*Figure 4.23: Prototype 03 - Product page after clicking "Vis i tabellform" (Show as table) in the filter. Showing comparable nutrition values for a meat burger and a plant-based burger.*

They were then asked if they would use the application, and if so, how they would use it. Some of the participants said they would try to use it before going to the store to find better alternatives. Other said that they would scroll through it a few times to get a better overview of what various products contains of ingredients and nutrition. Participant 14 said that he lives with his parents, and therefore eats what his parents buy most of the time. He would therefore not use it as he does not do much shopping.

Lastly, they were asked how they thought this application could affect their decisions and eating habits. Most of them said that they would probably be more aware of what products contained and try to find other alternatives that taste good. Participant 11 said she felt more aware already, after the user test of the prototype application. She said that she would use the application to check nutrition values in processed and new food products. Participant 13 said that he did not think his eating habits would change much as he already tries to eat healthily, but that it could be easier for him to find a healthier option using this application. Participant 10 said that

it could be useful for finding products that matched one’s goal or need. If you are looking for protein, you can sort this by which products contains the most protein.

# 5. Discussion

This section will discuss, analyze, and relate the results to previous research. The utility value and the strong and weak aspects of the research in this thesis will be discussed.

## 5.1 Evaluation of results

Results from this research can indicate that there is a lack of nutrition knowledge, especially in plant-based food products. This correlates with what was found in previous research described in the Literature review section (WHO, 2017; Hartwell et al., 2021; Tangsripairoi et al., 2019). According to WHO (2017) people generally have little knowledge about basic health. Thus, many people don't have enough knowledge to make appropriate decisions for their health. This may include knowledge about diet and specifically about nutrition values. In the research done by Tangsripairoi et al. (2019), they found that many did not clearly understand nutrition fact labels. The results from the user testing in this thesis contradict this, as most of the participants in the third iteration of the user testing said that they understand the meaning of most of the nutrition values. This could be because in this prototype application nutritional values of plant-based products are put in perspective with other products. This can make it easier to get a better understanding of what values a product should or should not contain. Tangsripairoi et al. (2019) developed their app, WhatTheHealth, where they found the function for comparing nutrition to be very popular. Participants in the research in this thesis seemed surprised when they saw the difference in nutrition when comparing a random meat burger with a random plant-based burger. This may strengthen the theory that people do not have enough knowledge about basic health, especially nutritional differences between meat products and plant-based food products.

Previous research and results in this thesis may show promising results for positive change in behavior related to the use of health or dietary apps. The results from this thesis also imply that people seem positive about the use of such an app. When asked how they would use it, they seem to think the application could impact their decision when buying food products for a healthier diet. All the users in the third iteration of user testing said that they already use some sort of health application.

Although none of them used applications related to diet, this may imply that they are familiar with using smartphone applications for behavior change.

The decision of buying a product may however be affected by several aspects. The research on the French application, Yuka, found that taste, price, and habit as well as nutrition is important factors when deciding what product to buy (Southey, 2019). When presented with the prototype application made in this thesis, people seemed to be affected by the nutrition values, but they also commented on the taste. When presented with a plant-based burger that had the preferred nutrition for many, people seemed conflicted as they thought they would not like the ingredients in this specific burger but would prefer the nutrition values in this burger over the meat burger.

The feedback from the user testing amplifies the importance of universal design in smartphone applications. In the first iteration of the prototype, there were several areas where the contrast was not high enough. The UCD approach and he inclusion of users throughout the process was very valuable in terms for creating a highly usable prototype application. During the user testing, several participants gave feedback related to the low contrast. This was also the case for the size of some text, where it was too small for some participants to read it. This shows that it is important to follow the WCAG guidelines and have universal design in mind when designing (Patch, Spellman & Wahlbin, 2015).

## 5.2 Utility value of results

The research in this thesis may provide a better understanding of the global problem regarding low health literacy and its consequences, while also providing a possible solution. Both literature and results from the user testing may suggest that there is a problem regarding the general knowledge of basic health information. However, the results show how an application may be very helpful in creating awareness and behavior change towards a healthier diet. Long-term effects remain to be seen, but the potential is great. If people use the application to buy healthier products and thus have a healthier diet, it may reduce the number of people affected by diseases related to an unhealthy diet (WHO, 2017).

## 5.3 Limitations

As it was a short thesis, there were limitations due to time. It was decided that only a prototype application was going to be developed, rather than a fully functional code-based application. While this was more time efficient, it came with some limitations.

Figma, which was used for the development of the prototype, does not support the implementation of all accessibility features that should be implemented in such an application. While some aspect is not possible to implement, some are too time-consuming. Scalability and language may be possible, but a new screen would have to be designed for each screen size, device, and language. This meant that the prototype only got tested on an iPhone 11 with only Norwegian-speaking people.

Limited knowledge and experience with Figma may also have affected the research. While Figma is easy to use and familiar from previous projects, there may be features and potential for more experience. This could have affected the time and execution of the prototype. More experience with Figma could have created room and time for a more interactive and accessible prototype, and thus allowed for more iterations of user testing or more complex user testing.

The user testing was performed in a controlled setting. As the prototype was not fully interactive, it was tested in a controlled environment with specific tasks. This limits how logical and realistic the results are, as the application may not be used like it is presented in the user test, in real life.

The research is done on a relatively small sample of potential users. The questionnaire consisted of 37 participants, and the user testing got performed on a total of 14 participants. This is a relatively small group of users and may not represent all the potential users. As they were gathered through convenience sampling, bias and over or under-representation of user groups may be present. There was found to be a slight overrepresentation of participants living in Norway in the questionnaire. This was however put in a bar chart (Figure 4.7), which showed that there was no huge difference in answers based on where they live. The participants in the questionnaire were between 14 and 54 years old, from eight

different countries. The participants in the user testing ranged from 18 years old to 52 years old. As the prototype application was in Norwegian language, all users participating in the user testing were Norwegian. The distribution of male and female were almost equal, but the user testing had slightly more male participants. Although this represents many potential users, it may not be enough to generalize the results. Several population groups have been left out. This application may not be relevant for many people below 18 years old as they tend to live at home with their parents, and thus do not buy food. People older than 54 years on the other hand, could be relevant as they often shop for themselves. Elderly people may not be as used to technology as younger user groups. Not performing user testing on this user group may therefore be a weakness in the research. The prototype application is also not tested on people with disabilities or people with diseases related to an unhealthy diet, which again leaves out an important group of potential users.

## 5.4 Significance of results

While there are some weak aspects of the research in this thesis, some aspects make the research significant. The results can be considered more credible as they strongly correlate with the literature and similar research presented in the Literature review. There is however little research done specifically on how a mobile application can help create awareness and change behavior towards a healthier diet in the Norwegian market. Although there exist similar applications, such as Yuka, there are no such applications adapted for Norwegian products. Also, the focus on plant-based food products makes this research stand out. The results may be significant in the sense that it combines research on a plant-based diet, knowledge about nutrition values in such a diet, and how an application can help create awareness and change in behavior.

# 6. Conclusion

In this thesis a prototype of a universally designed smartphone application for easy access to nutrition values in plant-based food products was developed. User Centered Design was used for design and research. Feedback from users throughout the design process increased the usability of the prototype application. This prototype has been used to investigate the following research question and its two sub-questions:

**To what extent can a universally designed smartphone application where consumers can easily assess and compare the nutritional value of plant-based food products change people's behavior and mindset towards a healthier diet?**

**How can it help people make healthier decisions regarding their diet?**

**How can it help people be more aware of nutrition values in plant-based food products compared to meat products?**

The results from this thesis suggest that such an application can help people towards a healthier diet. It can help people by creating awareness of what nutrition values both plant-based food products and meat products contain. By being able to easily access nutrition values for different products and optionally compare them, nutrition values are put in perspective. Thus, an application can create more awareness of the fact that healthier options are available. By being able to easily access this information, the users can access and compare nutrition values and choose the healthier option. The results indicate that the users got more aware after just trying the application out and that they would use it for finding healthier options. Based on the presented findings, this thesis concludes that universally designed smartphone application can be a helpful tool for individuals to gain more health literacy and eat healthier.

## 6.1 Future work

Further development of the application is recommended. In this short master thesis, a prototype was created. Further development and implementation would allow for more functionality and thus more complex user testing. Further implementation may include more functionality and accessibility features. Limitations in Figma left out some aspects, such as scalability, support of screen reader, and more languages. User testing also revealed that other aspects can affect people's decision of what food products to buy. Implementation of origin or products, price, and taste allows for further research on how people decide what to buy.

Additional research should look at the long-term effect and include more users. Here, a small set of users tested a prototype application. A fully interactive application can allow for user testing with more users. Testing on populations that were left out in this set of user testing is important for further work. Elderly people and people with disabilities can provide useful feedback, not considered in this thesis. Another user group is people who have a disease related to an unhealthy diet. This can give important feedback on how they would use the application and whether it would have an impact on their health. The application can also be tested in a more realistic setting where users get to test it over a period and report back on how it affected their decisions.

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