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Universal Design in ICT

A nutrition calculator to assist healthier food production : Focusing on the usability perspective

Lars Hammer

Department of Computer Science

Faculty of Technology, Art and Design

OSLOMET

Preface

In my time as a student, I have learned to develop a passion for software development. In the last two years, through my specialization I have learned the importance of universal design and the focus on accessibility when developing systems. I have always been interested in trying new food products as soon as they appear in the store. That is why I felt this project was perfect for me. Learning more about the process for labeling a product has been an interesting journey. Seeing how complicated the   process for labeling a product can be, have been an eye opener. That is why being a part of the development process for this calculator, that will make the jobs so much easier for companies and manufacturers in the food industry, has been an enjoyable experience. Evaluating and conducting usability tests has been a new and exciting experience for me, where I have learned much along the way.

I would like to express my sincere gratitude to my supervisor, Way Kiat Bong for his guidance and support throughout my work. His knowledge and experience have been instrumental in shaping my ideas and providing me with insightful feedback. Thank you for your unwavering support and for pushing me to achieve my best. I would also like to thank Fremtidsmat for helping me with finding participants. Also, thanks to every participant that took part in this study. Thanks for spending your valuable time with me testing and providing feedback on the nutrition calculator.

Abstract

In today's time, the focus on a healthy diet and nutrition has never been higher. Many new food products that enter the market is often labeled with a healthy claim to get the attention of the consumers. Some recognizable claims are, high in protein, sugar free, low on fat, low on calories, high in fiber, and so on. The manufactures and companies responsible for labeling the products, needs to follow a strict set of regulations, in order to add a claim to their label. This process can be long and complicated, especially for smaller companies. In Norway there are three main labeling schemes, the keyhole "Nøkkelhullet", nutrition claims "Ernæringspåstander", and health claims. To make this process easier, Fremtidsmat a Norwegian food cluster have created a calculator that will show if a product meets the requirement for "Nøkkelhullet". The function for the keyhole was developed in an earlier study, and in this study that prototype is further developed by implementing the function for nutrition claims. The goal of this study was to evaluate the usability of this calculator. The evaluation is based on a multi-method approach, with focus on Nielsen's heuristics, and feedback from participants. The feedback is comprised of testing tasks, questionnaires, and interviews. In addition, a SUS questionnaire is also utilized for evaluating the usability. Four iterations of the calculator have been tested by 5 participants. The findings show that there is little to no research on such calculator, and that this calculator is first of its kind. The evaluation found that the calculator has a high usability, with a SUS score on 85.5, giving the highest score possible, "Best Imaginable". This calculator has great potential for the future, and holds a great value for every company or manufacturer within the Scandinavian food industry. In addition to the calculator, design proposals for a login page and welcoming page for Fremtidsmat is evaluated and improved based on feedback from the participants.

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1. Introduction

Food, nutrition, and water has been, and is still the most important factor for human survival. Much have changed, from eating what can be found, to eating what we want. In today's food market there are many choices for eating, everything from meat, vegetables, junk food, vegan based products, and more. However, what is exactly nutrition? According to Barasi (2003) Everybody has their own experience of food and eating, which means that people would have different ideas about what is meant by nutrition. Some people might look at eating as a way to meet basic physiological needs and stop hunger, whereas other see food as a pleasurable experience, and something to anticipate and plan. These two represent the sayings "eat to live" and "live to eat" (Barasi, 2003).

Throughout the last decades, there has been much talk about eating healthy, and eat less calories. This is important as it can prevent illness and medical problems, but what is health food and a healthy diet? Healthy eating or good nutrition can be obtained by eating adequate, well-balanced meals, to support the body's needs. However, all bodies are different, and have their own needs, which means that a healthy diet might look different for one person to the next (Elahi, 2022).

A diet is something that evolves over time, and is influenced by many social and economic factors, that might interact in a complex manner to shape individual dietary patterns. Some of the patterns might be, income, prices, individual preferences and beliefs, cultural traditions, geographical and environmental aspect. That is why promoting a healthy food environment needs to include the involvement of multiple sectors and stakeholders, such as government, the public and the private sector. The government has a central role in creating a healthy food environment that will help enable people to adopt and maintain a healthier dietary practice. The World Health Organization have created a list that they mean are necessary for governments to follow for creating a healthy food environment, this list includes (WHO, 2020):

-Reduce incentives for the food industry to continue or increase production of processed foods, that contains high levels of fats, trans-fats, and salt/sodium;

-Exploring regulatory and voluntary instruments such as marketing regulations and nutrition labeling policies. As well as economic insensitive or disincentives (taxation and subsides) to promote a healthy diet;

-encourage transnational, nation and local food services and catering outlets to improve the nutrition quality of their foods. Also ensure the availability and affordability of healthy choices, and review portion sizes and prices.

According to WHO (2020) consuming a healthy diet throughout life, will help to prevent malnutrition, as well as a range of noncommunicable diseases and conditions. A big problem is however that there has been an increased production of processed foods, rapid urbanization, and changing lifestyles have made a shift in dietary patterns. More people are now consuming more foods that are high in energy, fats, free sugars and salt/sodium, and many people are not eating enough vegetables, fruits, or other dietary fiber such as whole grains (WHO, 2020). A study conducted by Juul, et al. (2021), looked into the eating habits of the U.S population, and how it has changed over the last 18 years. What they found out was that the U.S population is shifting towards a more ultra-processed diet. They found out that the consumption of ultra-processed food, grew from 53.5% of the calories in 2001, to 57% in 2018. This is a due to the increase of ready to eat or heat meals, such as frozen dinners. It also showed that the consumption of whole foods decreased from 32,7% to 27.4% of calories, and this is mostly because people eat less meat and dairy. The group that had the biggest increase in consuming ultra processed foods were older adults. In 2001 this age group ate the least amount of ultra processed foods, and the most whole foods. However, today this group eats the most ultra-processed foods and the least whole foods. Noteworthy, Juul et al, also stated that the high and increasing consumption of ultra processed foods in the 21st century may be a key driver of the obesity epidemic (Juul, et al. 2021).

In 2010, the health assembly developed a set of recommendations on the marketing of foods and non-alcoholic beverages to children. These recommendations help countries to design new policies and improve on the existing once to reduce the impact on children of the marketing of foods and non-alcoholic beverages. Furthermore, WHO has also developed region specific tools, such as regional

nutrient profile models, where countries can use this to implement the marketing recommendations (WHO, 2020).

1.1 Fremtidsmat

With all the regulations and laws regarding correct labelling, it can be difficult to understand and navigate through every regulation to find out if a product can be labeled with either "Nøkkelhullet" or "Ernæringspåstander". This process might also be time consuming because each regulation needs to be looked through to ensure that no laws or regulations are broken. To help speed up this process, a company called "Fremtidsmat" is creating a simple and trustworthy nutrient calculator that will help make this process much easier for producers, and manufactures that create food products.

To get a better understanding of Fremtidsmat, it is important to look at their values, what they stand for and what they do. Fremtidsmat is a Norwegian food cluster that are focused on developing food with better health properties and sustainability (Fremtidsmat, n.d). A food cluster is a group of companies in the food industry located close to each other, such as region, or nation based. The cluster works together to improve competitiveness through collaboration, innovation, and sharing of resources and knowledge (Isaksen, 2019). Fremtidsmat's goal is for everyone to be able to eat, and drink with a clear conscience. The benefits for a cluster is to develop new, innovative, and healthier food and beverages through mutual cooperation. This will in return increase the competitiveness and the innovations of the members. This will help contribute to a long-term growth and margin improvement for all the member companies. The cluster aims to be a focal point and a powerhouse for the development of healthier industrial food and more sustainable food products. This can be achieved by focusing on the agricultural and fishing industries in the region around the Oslo fjord, using primarily Norwegian raw materials (Fremtidsmat, n.d.). Fremtidsmat has a mission where the goal is to contribute to the development of more healthy and sustainable meal solutions. With help from the member companies, the plan is to increase demand among consumers and sales channels, such as

grocery stores, large households, new channels, and export markets, etc. (Fremtidsmat, n.d.)

To help the members of Fremtidsmat to create and develop food or beverages that are healthy and sustainable, Fremtidsmat are developing a calculator in collaboration with Oslo metropolitan University that will find out if a product is meeting the requirements for "Nøkkelhullet", nutrition claims, and Health claims ("Helsepåstander"). In a previous master thesis, a prototype of the nutrition calculator was developed. In that version the function for Nøkkelhullet was created. In this master thesis, along with another master student, the calculator is further developed by implementing the feature nutrition claims. Figure 1.1 shows the interface of the first version for the calculator.

Figure 1-1 The first version of the calculator, showing a product meeting the requirements for Nøkkelhullet

1.2 Research aim

The use of nutrition claims is a complicated process, and it can be difficult for manufactures to label their product correctly. Fremtidsmat's nutrition calculator is

created to help make this process easier. The goal for this master thesis is based on this premise. The first objective is to evaluate the usability of the calculator, as well as the new feature for nutrition claims. To assess the calculator, four iterations of usability testing, and semi-structured interviews was conducted to improve and find issues regarding the overall usability of the calculator. The other objective was to design and evaluate a member log in page, and a welcoming page after the log in is complete. Both objectives focused on the usability, and the design. The target was to create a nutrition calculator that can be used by as many people as possible.

1.3 Ethical Considerations

For this study, there will be conducted multiple usability testing with different participants. For this reason, it is important to follow the correct guidelines for handling personal information. When dealing with personal information from participants, ethical considerations should be a top priority. It is important to obtain informed consent from each participant before collecting any personal data. Participants should also be informed of the purpose of the data collection, how the data will be used, and who will have access to the data.

The work that is being done in this paper, is with a collaboration with the Oslo metropolitan University. This means that for a research institution, it is a legal requirement to document all processing of personal data. To meet this requirement OsloMet have entered an agreement with a third-party vendor called SIKT that can assist with this process. SIKT offers services related to processing personal data (Sikt, n.d.). By using services from SIKT, the institution can be assured that the requirement to document personal data processing is met. This is achieved through a registration process where SIKT gains insight into the processing of personal data in the institution and assists with documenting this process (Sikt, n.d.)

For this research, the personal data that is collected is name, age, occupation, as well as audio/video recordings from the meetings. The participants that will be included in this study, are members of Fremtidsmat, and have participated in similar tests for earlier master students from OsloMet. This means that they are familiar with the process and know what their data will be used for. However, before going ahead

with the testing, SIKT needs to approve the form before the testing can start, this can take up to 30 days. That is why it is important to send in the form as quick as possible, in case there should be any trouble getting the request approved. When finished, all personal data such as audio and video recordings will be deleted. Any personal information shown in this paper, will not trace back to the participants, and their identity will remain anonymous.

2. Literature review

In this chapter the goal is to find research that might be related or similar to the nutrition calculator developed by Fremtidsmat. Another topic is to see if there has been any research on evaluating a food calculator or another nutrition website. The focus is related towards Nielsen's heuristics. By looking into similar content related to nutrition calculators it can help find out what works, and what might need some extra consideration based on the findings.

2.1 The Norwegian food labeling system

The Norwegian government have created different regulations regarding labelling and for marketing food and beverages. There are many different regulations, and the most known regulations that the consumers are aware of are "Nøkkelhullet", and "Erneringspåstander".

"Nøkkelhullet" is labeling scheme established by the government to make it easier for consumers to make healthier choices. When choosing food products with "Nøkkelhullet" individuals will be consuming less fat, sugar and salt, and get more fiber and whole grains. This can be beneficial for a person's health. The label for "Nøkkelhullet" is placed on the packaging for the product. You can also find the label on bread, meat, and cheese that are not wrapped. All fresh fish, fruits, berries, vegetables, and potatoes are "Nøkkelhullet" products, even if they are not labeled with the green and white keyhole (Helsenorge, 2022).

Nutrition claims is any form of statement that includes, suggests, or give the impression that a food product has a special beneficial nutritional property (Mattilsynet, 2018). The reason for these beneficial properties is the energy (caloric content), the nutrients or other substances that the food contains. Nutritional claims can be based on scientific evidence, but it is important to be cautious and not rely solely on such claims when making dietary decisions. The claims are divided into three categories: "contains", "contains in increased or decreased amounts" or "does

not contain". This means that a nutrition claim, states something about the content of nutritionally beneficial substances. (Mattilsynet, 2018).
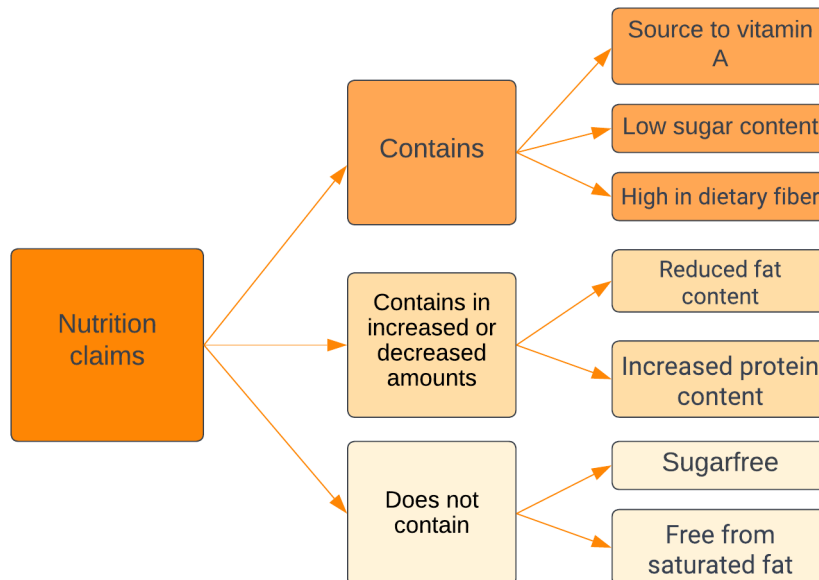
Figure 2-1 Example of the three different claims with approved nutrition claims for each category (mattilsynet, 2018).

There are made many different regulations and rules for how and when to use nutrition claims on a specific food product. One example that shows how nutrition claims can be used is: the claim is that the product is a "protein source". An alternative formulation is "Source of protein". For using this claim at least 12% of the energy content in the food must come from proteins (Mattilsynet, 2018).

Not all products that meet the requirement can use the term "Source of protein". To use this term the product needs to include a significant amount of protein. This is done to avoid misleading information for the consumer. For example, a standard, sugar free energy drink contains 0,4 g of protein and 3 kcal pr 100 g. This means that 53,3% of the energy content is made up by proteins. So technically the drink can be classified as a "source of protein". But doing so it would mean false advertising, because in reality the product only contains 0,4 g of protein pr 100 g (Mattilsynet, 2018).

2.2 Nutrition calculators

Today, there are many different nutrition calculators on the market. However, many of the calculators are directed to the consumer, where they can calculate their BMR, BMI, diet plan, food tracking, calorie count, etc. The calculator produced by Fremtidsmat is on the other hand created towards the producers or manufacturers that creates and label the food. On the open market today, there are no other nutrition calculators that can resemble Fremtidsmat's calculator. The calculator is providing a calculation to find products that meets "Nøkkelhullet" and "nutrition claims". Based on the other calculators available, no other product or company are offering the same features. Especially for calculating "Nøkkelhullet". "Nøkkelhullet" is a labeling scheme restricted to Scandinavia, meaning that international companies and manufacturers is not working with this requirement. In the Scandinavian countries, the only way of calculating the requirements for "Nøkkelhullet" is done manually.

However, there are one calculator on the market that share some similarities with Fremtidsmat's calculator for calculating nutrition claims. This calculator will be further looked into later in the literature review. When compared, Fremtidsmat is providing a more complete calculator with more features available than any other nutrition calculator on the market. Fremtidsmat's calculator works by first enter the name of the food, then select what kind of food category it belongs in, such as vegetables, flour, milk, etc. Then the next step is to fill in how many calories, fat, protein, salt, etc. Then the result will show if the product meets "Nøkkelhullet", and what type of nutrition claim they can use.

This highlights that there is a place and a market for this product, as Fremtidsmat's calculator is innovating and first of its kind.

2.2.1 Food labelling information systems

The European Union have created a system called the food labelling information system that provides a user-friendly solution that helps users to select food and automatically retrieve the mandatory EU labelling indications (EU, n.d.). This is more

of a guideline for users than a calculator, but it works in a similar way. First a user is asked to select a language, and then choose the food category. This category has 15 subcategories ranging from A-O, such as "Dairy products", and "Fruits and vegetables". In each category there is a new subcategory, so for dairy products it is possible to choose, drinking milk, yoghurt, cream, cheese, or other dairy products. If a user chooses "yoghurt" they can click on the show results page, here it will list all regulations and laws for labelling a yoghurt product. In the case for yoghurt there are 14 mandatory regulations that needs to be followed. These include: "The name of the food", "List of ingredients", "The nutrition declaration", etc. On Figure 2-2, the regulations in "The nutrition declaration" is shown. It gives detailed information on how to label correctly, what is mandatory, and what information is not needed (EU, n.d.)

The tool from EU is a great instruction guide for manufacturers to use. It shows what is expected and required for labelling a product, with a detailed list of all regulations related to each product (EU, u.d). However, since this is a guideline and not a calculator the producer needs to manually find out if their product meets the requirements. This still makes the process difficult, because they need to look into each regulation, which can be confusing, and difficult to understand for many people. Therefore, it is necessary to look into a calculator that will give a clear answer whether they met the requirements for nutrition claims or not.

EU>Regulation (EU) 1169/2011>Article 9>1.>(I)

The mandatory nutrition declaration shall include the following:
(a) energy value; and
(b) the amounts of fat, saturates, carbohydrate, sugars, protein and salt.
They shall be expressed per 100 g and per 100 ml.

The content of the mandatory nutrition declaration may be supplemented with an indication of the amounts of one or more of the following:
(a) mono-unsaturates;
(b) polyunsaturates;
(c) polyols;
(d) starch;
(e) fibre;
(f) any of the vitamins or minerals listed in point 1 of Part A of Annex XIII, and present in significant amounts as defined in point 2 of Part A of Annex XIII of Regulation (EU) No 1169/2011.

Annex V of Regulation (EU) No 1169/2011 includes a list of foods which are exempted from providing the mandatory nutrition declaration. Those exemptions do not apply to foods for which nutrition and health claims are made, or to which vitamins and minerals have been added, in accordance with Regulations (EC) No 1924/2006 and (EC) No 1925/2006.

Please note that several options and modalities exist on how to provide the nutrition declaration.

Figure 2-2. The figure shows the guidelines regarding yoghurt in the section, "The nutrition declaration". (EU, n.d)

2.2.2   Essentia Protein Solutions

Essentia protein solutions is a global company that produces animal protein solutions for the food and beverage industry (Essentia, n.d). They have created a nutritional calculator, where it is possible to type in the amount of protein, fat, and carbohydrates in a product. Based on the number, it calculates the total energy (kcal) and how much of the energy comes from protein. This calculator is used so that a company can figure out if their product meets the protein classification according to regulation (EC) No 1924/2006. This regulation determines what labelling they can use, such as "Source of protein", "High in protein", or "Enriched" (Essentia, n.d.).
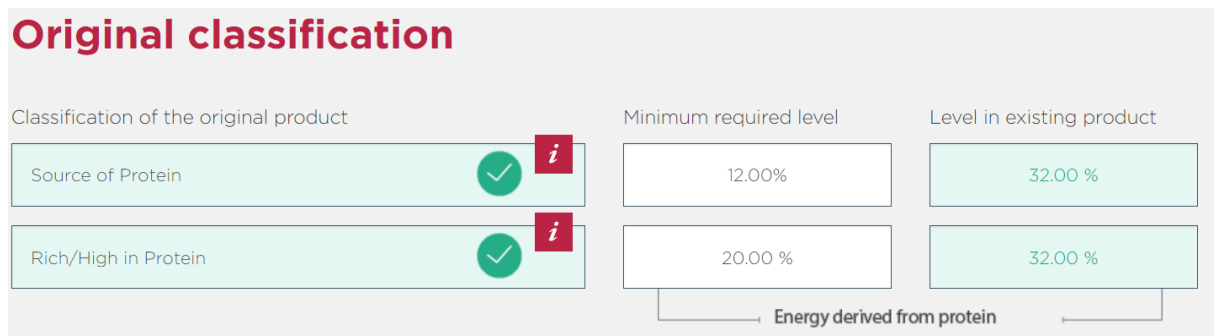
Figure 2-3. Gathered from Essentia, showing which nutrition claim that can be used on a product (Essentia, n.d.).

On the figure above, it shows what nutrition claims can be used for labelling the product "neck chops". Both "source of protein" and "Rich/high in protein" can be used on the label. To use the term "source of protein" the minimum requirement of the energy derived from protein is at least 12%, and to use rich/high in protein it needs to be 20%, and neck chops meet both the requirements with 32% of the energy deriving from protein (Essensia, n.d.). This calculator is only showing nutrition claims regarding protein, so any other claims need to be found using other tools, or manually tested. This is where Fremtidsmat's calculator comes in as a better alternative. This is because it will show the nutrition claims for every category, including free of sugar, source of vitamins, high in fiber, low in saturated fat, etc. and not just source of protein. This is why Fremtidsmat's calculator, is a much needed system, due to its capabilities to show every nutrition claim possible for a product, on one single interface.

2.3 Nielsen's Heuristics

In 1990, Jackob Nielsen created a set of ten guidelines (heuristics) to help improve User interface (UI) design (Nielsen, 2020). The 10 heuristics are used as measures for creating an accessible website, and a website it is often tested against each principle or developed with the principles in mind. That is why it is important to know about each of them to better understand how they are used to evaluate a website.

1 - Visibility of system status

The first principle is about making sure that the users are informed about their actions, and what will happen at a given interaction (Nielsen, 2020).

2 - Match between system and the real world

For this principle the system should always speak the user's language, as well as follow real world conventions. For example, use the icon calendar to signal opening a calendar.

3 - User control and freedom

For this principle a UI design should never impose an action on the user or make a decision for them. Instead, it can give suggestions, on which path a user can take. If the user made a mistake or changed their mind, they should be able to undo or redo their actions.

4 - Consistency and standards

This principle is about using the same language throughout the system to avoid confusing the user.

5 - Error prevention

This heuristic shows that a good design should always prevent problems from occurring. For example, before a user deletes a file, give a waring, and make sure that they want to delete that file.

6 - Recognition rather than recall

For this, Nielsen's heuristics aim to reduce users' cognitive load, this also includes their memory capacity. A user should not have to remember every command, but instead the system should have shortcuts, or a menu to navigate easier.

7 - Flexibility and efficiency of use

For this principle the design should benefit both inexperienced and experienced users.

8 - Aesthetic and minimalist design

This principle shows that the developer should consider functionality over aesthetics. That is why one should create interactions that only contain essential information. Any unnecessary visual elements might overwhelm and distract the users.

9 - Help users recognize, diagnose, and recover from errors

This heuristic focuses on the designs where it can help the users to identify and find solutions to eventual errors and problems. Use error messages with plain text, code free and clear.

10 - Help and documentation

The last and final Nielsen's heuristics is about the documentation that will help users understand how to perform their tasks. In some cases, a step-by-step tutorial with pictures can be a good solution for a problem (Nielsen, 2020).

2.3.1   PENUMAT

Personal Nutrition Management Tool (PENUMAT) is an interactive website that aims to help individuals find nutrition information on the internet. It was intended for use by healthy adults with no chronic or acute disease, and who are not undergoing any medical treatment. Bozkurt et al. (2011) did a study where they wanted to find out if the website is accessible. They decided to evaluate the usability of the PENUMAT with the use of a multi method approach which includes Nielsen's heuristics. The researcher gathered 10 participants to help evaluate the site. The participants were given testing tasks to interact with the web page. The data that they acquired were classified according to the 10 heuristics (Bozkurt et al, 2011).

What they found out was that each heuristic was violated at least once. It shows that the most common heuristic that was breached was "Aesthetics and minimalist design", this happened nine times. The second was "User control and freedom" with eight breaches. From the questions that they asked the participants, they found out that "length of the information page" (5/10), "Navigation" (5/10), and "Desire to add all food records belonging to the same meal in one go" (5/10), was the problems that

had the highest frequencies. When the creators were developing the site, it was shown that Nielsen's Heuristics was considered in the designing phase, although some usability problems as seen did occur in real life settings. It has been shown that, the findings clearly proved the benefits of in-depth usability analysis as part of the development cycle (Bozkurt et al, 2011). By using Nielsen's heuristics in the planning phase it is possible to prevent usability problems, however, it is still possible that problems occur. That is why, creating a detailed and structured plan is important during the planning phase, as well as testing along the way to eliminate potential problems.

2.3.2 mHealth Application

mHealth, or Mobile Health is defined as health and medical prevention and treatment supported by exponential technologies, such as wireless gateways and connectivity, biosensors, and wearable personal technology, with more. According to Nurhudatiana and Seo (2020) there has not been much focus on creating a mHealth app with usability and accessibility in mind. That is why they conducted a three-step study where they evaluated an existing app called "Halodoc", then redesigning the application, before evaluating the new redesign with the same criteria. To evaluate the application, the researchers used Nielsen's heuristics, both before and after the redesign. The researchers recruited four experienced UI/UX designers to evaluate both apps and recorded the data. What they found out what that the original application had 50 usability issues. The most frequent issue was related to "visibility of system status" with 11 out of the 50 usability issues. For "recognition rather than recall" they got seven issues, whereas six issues were reported for "user control and freedom", and "aesthetic and minimalist design". There was not any problem with "match between system and the real world, and only one cosmetic issue with "help and documentation". They also found two with major severity that was found on

"Error prevention", and "user control freedom. Table 2-1 shows all the problems they found on the original application (Nurhudatiana & Seo, 2020).

Table 2-1. Shows all heuristic violations on the original application, table copied from Nurhudatiana & Seo (2020).

No.	Heuristic Item (0: no issue; 1: Cosmetic; 2: Minor; 3: Major; 4: Catastrophic)	Qty (# of issues)	Mean (Scale)	Stdev (Scale)
1	Visibility of system status	11	2.82	0.98
2	Match between system and the real world	0	0	0
3	User control and freedom	6	3.0	0.94
4	Consistency and standards	5	2.4	0.89
5	Error prevention	5	2.2	0.84
6	Recognition rather then recall	7	2.43	0.97
7	Flexibility and efficiency of use	4	2.75	0.5
8	Aesthetic and minimalist design	6	2.17	0.75
9	Help users recognize, diagnose and recover from errors	5	3.4	0.55
10	Help and documentation	1	1	0
	Total	50		

The researchers redesigned the app based on the issues fond in the original app and made a new prototype. The new redesign of the application was then tested again by the same participants. Every participant agreed that the usability issues that they found before had been addressed, and the overall usability of the app had improved (Nurhudatiana & Seo, 2020).

2.4 Universal design

Universal design (UD) is a term that has become more and more popular over the last years. UD is the design and composition for an environment where it can be accessed, understood, and used to the greatest extent possible by everybody, no matter their age, size, disability, or ability. UD is not a special requirement that is only beneficial for a minority of the population, it is a fundamental condition for good design. If an environment such as a web page is accessible, convenient, usable, and easy to use, everyone wins. If considering all the different needs and abilities throughout the design process, UD helps to create products, services and environments that will meet all the people's needs. In other words, universal design is good design (NDA, n.d.(a)).

Ronald Mace, and his work group came up with 7 principles for universal design back in 1997. The principles are made as a guide for designing environments, products and communicators. The center for Universal Design in NCSU claims that the principles can be used to evaluate existing design, guide the design process, and educate the designers and consumers about the characteristics for more usable environments and products. (NDA, n.d.(b)).

In a paper done by researchers Du & Bong (2022), a study was conducted where they evaluated mobile applications for a healthier lifestyle, before redesigning the application to better meet the universal design principles. They did the test on three different dietary applications, where they asked ten participants to complete six tasks regarding navigation, and usability. What they found out was that for all three apps, the participants struggled to log their weight. Eight of the ten participants needed guidance to perform the task. Another found was that there often were to low of a color contrast in some interfaces. This resulted in some users not being able to recognize clickable buttons and search input fields. Two of the applications were deemed to have too much information, and the information was also to scattered around. There was also a lack in instructions for first time users. Many of the features provided by the applications, came without any information on how to use them (Du & Bong, 2022).

There were a lot of accessibility challenges for all three applications, so the researchers came up with ideas for improving the usability and make it more accessible with the help of UD principles and Nielsen's heuristics. The first thing they did was related to the UD principles "simple and intuitive use", and "perceptible information, and "visibility of system status" from Nielsen's Heuristics. They wanted to make it easier to differentiate between "current weight" and "todays' weight". The second thing they did was regarding the same UD principles and heuristics, it was used to ensure that the new design offered more instructions and information on pages where a user can get confused, such as the barcode scanner. The third redesign proposal was for the UD principle "simple and intuitive" and "aesthetic and minimalist design" from Nielsen's heuristics. This was regarding more categorization for the displayed information to help simplify the calorie summary. Another change that they proposed was for the units of measurement. Here they offered more options for measurements to meet the UD principle "equitable use", this is done to make the design usable and marketable for alle users, regardless of their preferred metric usage. The heuristic "match between system and the real world" emphasizes that the system should follow real world conventions by having information appear in a more natural way. The last design proposal was to make a tutorial to assist first-time users and users how might need guidance. This strengthens Nielsen's heuristic "Help and documentation", here they also provided a skip introduction option. For the final touch they checked all the color contrasts, up against the requirements of the Web Content Accessibility Guidelines (WCAG) (Du & Bong, 2022).

According to Ahmed (2022) who developed the first version of Fremtidsmat's calculator, they had a clear focus on making the calculator as accessible as possible. He followed the criteria's given by WCAG, to make an accessible website, he also made it so that the whole site is responsive, this will make the application work on all screen sizes. When the first prototype was finished, they used WAVE to evaluate the page (Ahmed, 2022). WAVE is an accessibility evaluation tool that scans the webpage for errors or criteria's that does not meet the requirements for WCAG (WAVE, n.d). Based on the results from WAVE, the developers were able to find errors that was not noticed during development, and made changes to the page (Ahmed, 2022). This shows that the first prototype for the calculator was developed with accessibility in mind. With accessibility features already imbedded into the

website, it can make it easier to follow the same steps regarding future development and testing, to ensure a user-friendly and easy to use interface.

2.5 Member login page

A second aspect of this paper is to propose a design for the "member login page" for Fremtidsmat. They want the calculator to be an offer for the members of Fremtidsmat. So, to ensure that, they need a login function for the members, this will ensure that only the members can access the calculator. For this function, only the login page will be designed, and not the page for registering an account.

User authentication is a well-known term in computer security, and is used to establish who the user is, verifying this identity, and providing proper access to the resource that the user is allowed to use. User authentication is important to use for multi-user computer, operating systems, and services with multiple users (Bardram, 2005). The most common and widely known from for login is username/email and a password. However, in the last years biometric identification have become a more popular and user-friendly alternative for gaining access. Fingerprint, and facial recognition is the most used as of today for authentication a person. For Fremtidsmat, the most optical option is using the traditional email/password alternative. According to Bardram (2005) a few studies have identified some potential usability problems regarding the use of passwords and the organizational policies surrounding it. Adams and Sasse (1999) found out that mechanisms and policies for increasing security, such as frequent changing of passwords had the opposite effect on the security. The reason is because users would made easy-to-remember passwords, and wrote the down, thereby lowering the security. This means that the security mechanisms that are incompatible with work practices may be circumvented by users and thereby undermine system security overall. However, Adams and Sasse (1999) did find out that users are quite motivated to support the security of the system, but the issue is that the users are unable to determine the security implications of their actions.

In a study done by Yuan et al. (2014), they analyzed the usability of three online banks login interface based on eye tracking movement. Based on the results from the

eye tracking they found out that the login entry, account login information and other key control buttons, should be placed in the upper left corner, this is where the eye quickly locks the target. They also found out that the interface should have a moderate amount of information on the page, use more appropriate proportions, have a reasonable font size setting, it should also be harmonious, simple and give a warm design style (Yuan, et al, 2014).

When it comes to designing a login interface, Tran (2019) have created ten recommendations to follow to ensure that a login interface is as great as possible. For the proposed design, some of the principles will be considered, and used in the design process.

The first suggestion is to "Make it obvious". The user should not spend long time looking for the login area, because the longer they look, the more frustrated they would be.

The next on is "KISS – Keep It Simple, stupid", this means that the login interface should be simple and straightforward for the users. Having two input fields with, enter username/email and password, is enough.

Next is "Distinguish between sign up and sign in". If a person is using the website to register as a new user, or if they are returning to login, it is important to make it clear where to go. That is why the login field should be distinct from the registrations field.

The next recommendation is to "skip username". There is a good reason for avoiding usernames, because it saves the users of having to come up with and remember a username. The best thing is to use email or phone number, as this is something most users remember.

The sixth tip is to give the opportunity to "show password". This is a great addition because, some users might have trouble using a keyboard, and miss click on characters, so by having the option to show password, can help them to login on the first try.

The last recommendation from the list is to "let users know that caps lock is on". By giving the user a warning that their caps lock is on, can help prevent many failed attempts, as some users might not know that the caps lock is activated (Tran, 2019).

3. Method

When deciding on an approach for conducting this study, different methods where considered. There are numerous methods available for assessing the usability of web-based applications, where each method having its own advantages and limitations (Bozkurt et al, 2011). Therefore, to overcome the limitations of using only one method and to obtain a comprehensive understanding of the use of the calculator, multiple complementary methods were utilized, as recommended by Bozkurt et al (2011). When Bozkurt et al. (2011), decided what methods to use, they ended up using, direct observations performed by the think out loud method, a questionnaire, and interviews. The think out loud method is a method where the participant verbalizes their thoughts while performing the tasks they are asked to do. After the think out loud session, a SUS questionnaire was given to the participants. A system usability scale is an inexpensive, yet efficient tool for assessing the usability of a web page. It provides an easy-to-understand score from 0 (negative) to 100 (positive) (Bangor et al., 2009). At last, they performed a semi-structured interview with each of the participants, to get their general impressions and thoughts on the website.

For this study, a similar approach to Bozkurt et al (2011), was utilized. It comprises of a multimethod approach, with four parts. The first part is a direct observation of the participants as they perform a set of testing tasks. In contrast with Bozkurt et al. (2011) the think out loud method was not used, as the thought process of the participants while using the calculator was not needed. After the testing tasks, it was followed up with a questionnaire, with questions from 1-5, then a semi-structured interview was conducted, to follow up on their thoughts and impressions. The final part was answering a SUS questionnaire.

3.1 Iterations

For this study four iterations of usability testing was conducted over the span of four months. Each iteration worked in a similar way, they all include a set of testing tasks, a questionnaire, and interviews. However, some of the testing tasks, and questions

change throughout each iteration. This is because as the calculator evolved, new functions and elements needed to be evaluated. So, questions that were relevant in the first iterations, might not be relevant in the final iteration. The SUS questionnaire was introduced in the third and the fourth iteration.

In addition to evaluating the calculator, the second part of the study was to come up with a design for a login page and a welcoming page. The participants were at the end of each usability testing asked to evaluate and provide feedback on the designs proposals. The feedback was then used to improve the design, for the next iteration, until a final design is shown at the last iteration, for both the login and welcoming page.

For the first iteration, the focus was on evaluating "Nøkkelhullet". This is also the only function that was available for the first iteration. The goal was to get feedback on the status, and the usability for the first prototype of the calculator. The results from the usability testing was sent to the master student responsible for the development. For the login page two different designs proposals was shown. The participants evaluated both and gave their opinion on each proposal.

The second iteration focused on the newly developed feature for nutrition claims. Here the goal was to gather information on the usability and the design for the new feature, as well as locate bugs or errors. Questions will also be asked about the keyhole, however this was not the main focus in this iteration. The feedback will be sent to the master student, to improve the function for the next iteration. For the login page, a set of new design proposals was shown. The new proposals were designed based on the feedback gathered from the first iteration. In this iteration the design proposal for the welcoming page was introduced. From this point forward the welcoming page was added to the usability testing and was shown after the login designs.

 The third iteration was also focused on nutrition claims. The goal was to see if the improvements from iteration two was sufficient, and well implemented. The testing tasks was aimed more towards nutrition claims, and not the keyhole, as this was more relevant, at this stage. For both the login and welcoming pages, a new set of redesigns was shown. Continue to get more opinions and feedback to improve the

overall design for both elements. The SUS questionnaire was also introduced to the participants in this iteration.

 For the fourth, and last iteration the focus was on the calculator as a whole. Here, the usability testing was aimed at both functions, in hopes to identify any new usability issues. The questions were also more detailed in order to find smaller problems/issues. The SUS questionnaire was also given to the participants here. For the login and welcome page, the last design proposals were shown, and evaluated by the participants.

3.1.1   Testing Tasks

The first part in each usability testing was the testing tasks. This method is a qualitative approach that determines how the users interact with the calculator. The usability testing that was given, consisted of five to seven tasks depending on the iteration, that the participants needed to perform. On the Table 3.1 it shows what testing tasks were given to the participants, for each iteration.

Table 3-1. All testing tasks given in the different iterations.

Testing Tasks:	Iteration 1	Iteration 2	Iteration 3	Iteration 4
Add a product that meets the requirements for "Nøkkelhullet".	Asked	Asked	Not Asked	Not Asked
Add a specific product that does not meet the requirements for "Nøkkelhullet".	Asked	Asked	Not Asked	Not Asked
Can you find out why this product does not meet the requirement for "Nøkkelhullet".	Asked	Asked	Not Asked	Not Asked
Add a product that meets the requirements for the nutrition claim "low in sugars".	Not asked	Asked	Asked	Asked
Add a product that meets the requirement for the nutrition claim "No added sugars".	Not Asked	Not Asked	Asked	Asked
Is it clear which Nutrition claim that can be used?	Not Asked	Asked	Asked	Asked
Add a product that does not meet any of the nutrition claims, or the keyhole.	Not asked	Not Asked	Asked	Asked
Add a fictive product. Select a random category and try to your best ability and fill in all fields so that it meets the requirements for «Nøkkelhullet».	Asked	Asked	Not Asked	Not Asked
If the task showed errors. Try to change the values, until the requirements for "Nøkkelhullet" is met.	Asked	Asked	Not Asked	Not Asked
If you want, play around on the calculator	Not Asked	Not Asked	Asked	Asked

3.1.2 Questionnaire

For the second part of the usability testing, the participants were asked to answer questions on a Likert scale ranging from 1-5. The questions were read out to the participants, and after rating from 1-5, a follow up question was asked why they gave

that score. The questions that were asked was meant to give a better understanding of what they think of the calculator. Each score was collected and analyzed by calculating the median score for every question. Since the questionnaire is giving standardized score options, it would make it easier to compare the results across the participants. By asking a follow up question it was possible to get a better understanding of the rating. What could have been done differently to reach a higher score, or what made them give a high score.

Many of the questions were the same in each iteration, but some were different, due to the usability testing being aimed at different features. The questions that were asked in the different iterations can be seen in Table 3-2 below. All the questions were the same, except for in iteration one, where questions about the nutrition claim was not asked, as this function was not implemented at that stage.

Table 3-2. All the questions from the questionnaire, for each iteration

Questions used in the questionnaire:	Iteration 1	Iteration 2	Iteration 3	Iteration 4
How did you like the calculator? (1= did not like it, 5= liked it a lot)	Asked	Asked	Asked	Asked
How would you rate the usability of the calculator? (1= unable to use, 5= highly usable)	Asked	Asked	Asked	Asked
How well did you like the function for Nutrition claims? (1= did not like it, 5= liked it a lot)	Not Asked	Asked	Asked	Asked
How well did you like the explanation given in Nutrition claims? (1 = did not like it, 5 = liked it a lot).	Not Asked	Asked	Asked	Asked
How useful do you think the calculator is? (1=not useful at all, 5= very useful)	Asked	Asked	Asked	Asked
How do you like the design for the calculator? (1= Not at all, 5= Liked it very much)	Asked	Asked	Asked	Asked
Is this calculator something that you would like to use in the future?	Asked	Asked	Asked	Asked

Questions used in the questionnaire:	Iteration 1	Iteration 2	Iteration 3	Iteration 4
(1= not at all, 5= very much)				

3.1.3   Interview

After the questionnaire, a post-test semi-structured interview was conducted to gather the participants general impressions and judgments about the calculator. The interview consisted of a set with pre-determined questions. Based on the answer from the participants, further questions outside the pre-determined set, could be asked to gain more insight, and to make sure any important information was not missed (Cohen & Crabtree, 2006). The interviews consisted of various questions, that were tailored to each iteration of the calculator. As the calculator became more complex, the number of questions asked to the participants increased. The additional questions were designed to gather their feedback on newly added features, and to address any concerns or questions from the developer. In every iteration a set of standard questions where used. This included what they thought of the calculator, what they did not like, and features that they would like to add or change for the next version. All the questions asked in the different iterations can be seen on Table 3-3 below.

Table 3-3. All the questions asked in the interview for each iteration.

Questions asked in the interviews:	Iteration 1	Iteration 2	Iteration 3	Iteration 4
1. What are your thoughts on the calculator?	Asked	Asked	Asked	Asked
2. What do you think about the design?	Asked	Asked	Asked	Asked
3. What do you think about the function Nutrition claims?	Not Asked	Asked	Asked	Asked
4. What do you think of the explanation given in nutrition claims?	Not Asked	Not Asked	Asked	Asked
5. What do you think of the color coding in nutrition claims?	Not Asked	Not Asked	Asked	Asked

Questions asked in the interviews:	Iteration 1	Iteration 2	Iteration 3	Iteration 4
6. What can be done differently about the nutrition claims function?	Not Asked	Asked	Asked	Asked
7. What do you think of the added buttons? Are they understandable?	Not Asked	Not Asked	Asked	Asked
8. Would it be beneficial to add a new subcategory in the Carbohydrates field? If so, what would you name it?	Not Asked	Not Asked	Not Asked	Asked
9. Would it be beneficial to add a warning symbol/text? If so, where should it be placed?	Not Asked	Not Asked	Not Asked	Asked
10. What did you not like about the calculator	Asked	Asked	Asked	Asked
11. Did you face any problems using the calculator?	Asked	Asked	Asked	Asked
12. For the next version of the calculator, what can be added, or made differently.	Asked	Asked	Asked	Asked

3.1.4   System Usability Scale (SUS)

A System Usability Scale (SUS) is an inexpensive, yet effective tool for assessing the usability of a web page. The SUS provides an easy-to-understand score, ranging from 0 (negative), to 100 (positive) (Bangor et al., 2009). This questionnaire is often used by researchers to evaluate the usability of a web page. One of the reasons why the SUS is popular, is the questionnaire is composed of only ten statements, meaning that it is relatively quick and easy for the participants to complete, and it is easy to score (Bangor et al., 2009). According to Sauro (2013), SUS can be used on a relatively small sample size. The lowest acceptable sample size is only two participants; however, this is not recommended. Using five participants is enough for early-phase usability testing.

The average SUS score is a 68. Any score above a 68 would be considered above average and anything below 68 is below average (Sauro, 2013). The scores can also be converted to adjectives, grades, acceptable, NPS (Net Promoter Score), and percentile range. In the Table 3-4 below Sauro (2018), created an overview of what each SUS score can be converted to.

Table 3-4. The use of Percentiles, grades, adjectives, and NPS categories to describe raw SUS scores (Sauro, 2018).

Grade	SUS	Percentile range	Adjective	Acceptable	NPS
A+	84.1-100	96-100	Best Imaginable	Acceptable	Promoter
A	80.8-84.0	90-95	Excellent	Acceptable	Promoter
A-	78.9-80.7	85-89		Acceptable	Promoter
B+	77.2-78.8	80-84		Acceptable	Passive
B	74.1 – 77.1	70 – 79		Acceptable	Passive
B-	72.6 – 74.0	65 – 69		Acceptable	Passive
C+	71.1 – 72.5	60 – 64	Good	Acceptable	Passive
C	65.0 – 71.0	41 – 59		Marginal	Passive
C-	62.7 – 64.9	35 – 40		Marginal	Passive
D	51.7 – 62.6	15 – 34	OK	Marginal	Detractor

In this study, the SUS questionnaire was added in the fourth and final iteration. The reason for only including it in the final iteration was because there was no need to have four different SUS scores. In addition, since the calculator has been improved on based on feedback from the first three iterations, a single measure of overall usability, would be enough to verify whether the final prototype of the calculator meets the criteria for a good usability score. In Table 3-5, the ten statements used for evaluating the SUS score is presented.

Table 3-5. The questions used to calculate the SUS score. Ranging from 1 (Strongly disagree) to 5 (Strongly Agree).

Questions in the SUS questionnaire. From 1 (Strongly disagree) to 5 (Strongly Agree).
1. I think that I would like to use this system frequently.
2. I found the system unnecessarily complex.
3. I thought the system was easy to use.
4. I think that I would need the support of a technical person to be able to use this system.
5. I found the various functions in this system were well integrated.
6. I thought there was too much inconsistency in this system.
7. I would imagine that most people would learn to use this system very quickly.
8. I found the system very awkward/ cumbersome to use.
9. I felt very confident using the system.
10. I needed to learn a lot of things before I could get going with this system.

3.1.5   Login page

For each iteration, an additional round of interviews regarding a login page was conducted. With a set of questions such as, what they want on a login page, the login proposal they liked the most, what they liked about the proposals, and what they did not like, were asked. The participants were shown two design proposals where they were asked to give their opinion on each proposal.

To design the login forms, Codepen was used. Codepen is a website that makes it possible to write and edit code in a browser and see the results in real time (Codepen, n.d). On Codepen it is possible to find templates created by other developers and use their template as a starting point. For this study two templets were found and edited to better fit the desired design. In addition, the recommendations and principles mentioned in the literature review, was used when making the proposals. The code was written using HTML and CSS.

3.1.6   Welcoming page

After iteration one, an additional request from the supervisor was made to design and evaluate a welcoming page for Fremtidsmat. The Welcoming page is the page a user gets sent to after a successful login. The criteria were to include a link to the calculator that can only be accessed by the members. To design the page, codepen was used to write the code, using HTML and CSS. Fremtidsmat's source code for the website was also collected by using "show source code" on Google Chrome.

3.2 Participants

For each iteration, Fremtidsmat oversaw recruiting participants for the testing. They contacted their own members to ask if they would like to take part in a usability testing. Some of the members expressed interest for participating in the usability testing. Because of this, it gave the opportunity to show the calculator to members of Fremtidsmat, and get a broader view on the usability, and gather different feedback for each iteration. In the first iteration one company participated in the testing. In the second and third iteration, a different company was used both times. In iteration four, three companies participated, where one of the companies was the same as in iteration one. The reason for using the same companies two times, was to get an updated review and feedback on the newest version of the calculator. By using the same participants, it can give an idea on the progress, and how the calculator has improved, over the course of the semester.

The usability testing took place both physically and online and were planned over email with each spokesman from the different companies. For the physical meetings, it took place at the company's own workplace, to make it easier for them to participate. The usability testing was performed on a Lenovo laptop owned by the interviewer, in addition a mouse and mousepad was laid out for the participants (Figure 3-1). Before each iterations the participants were asked to bring a product that they know meets the requirement for "Nøkkelhullet" that can be used in the testing. The reason for doing this was so that the participants can be sure the results are not tampered with, and that the calculator works as advertised.

The online usability testing was conducted over Microsoft Teams. The participants were given the link to access the calculator, and the interview watched through the sharing of screens. The testing tasks, questionnaire, interview, and the SUS questionnaire was all read out loud to the participants, and all answers were given vocally.

For each participant the usability testing is performed individually, and it took around 30-45 minutes to complete. For each physical session the participants were audio taped, and the online sessions were screen recorded with consent.
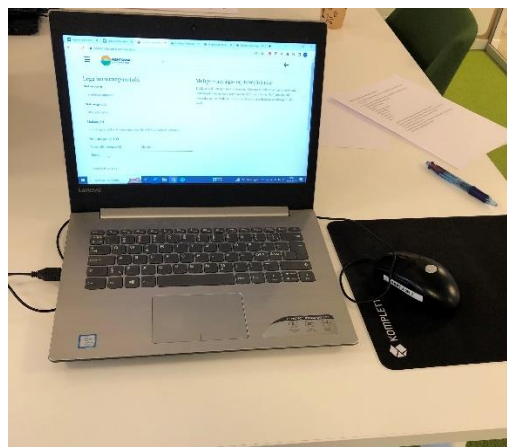
Figure 3-1. Showing the set up on the laptop, where the testing took place.

4. Results

In this section the results from the usability testing are presented. The results are shown for each of the four iterations. For each iterations the following will be presented, who participated, results from the testing tasks, the questionnaire, interviews, the login and welcoming page. At the end, the results from the SUS score are shown.

In Table 4-1, all participants from every iteration are listed. The "iteration number" indicates which iteration they participated in. The company is listed using A, B, C, and D. The company names are anonymized, due to privacy concerns.

Table 4-1 Every participant that took part in the usability testing.

Iteration number	Participant number	Age	Gender	Job	Familiar with the calculator	Company
1 and 4	1	36	Female	Product specialist	No	A
1 and 4	2	52	Female	Product specialist	No	A
2 and 3	3	37	Female	Chief adviser nutrients	Yes	B
4	4	47	Female	Clinical Nutrition physiologist	No	C
4	5	39	Female	Product developer	No	D

4.1 Iteration 1

In the first iteration two participants from "company A" was used for the Usability testing. P1 and P2.

4.1.1   Testing Tasks

Both participants completed their five tasks given to them in about 10-15 minutes each. They both completed all tasks without any major problems. Neither of them had any trouble navigating or understanding the calculator. Both participants said that their experience of using the calculator was pleasant and easy to use. However, they both were annoyed by the order of the input fields for the nutrients list. The nutrients list was not in the correct order as the regulation states. The order it was listed in was:

> **Energy, Saturated fatty acids, Fat, Protein, Carbohydrate, Added sugars, Dietary fiber,** and **Salt.**

> The correct order according to Mattilsynet (2015), should be, **Energy, Fat, Saturated fatty acids, Carbohydrate, Added sugars, Dietary fiber, Protein,** and **Salt.**

This turned out to be the biggest problem for both of them. They are often working with food products and are used to see the list in the correct order. After trying to add different products, both participants stumbled upon the same error/bug. When a product contains more carbohydrates pr 100g then what is allowed, the error message displayed "Added sugars are too high". It should instead say "Carbohydrates are too high". The error message can be seen in Figure 4-1.

Figure 4-1 Showing the error that occurred. Instead, of the message displaying "added sugars", it should say "carbohydrates".

P2 had some difficulties understanding how she could try and add a new product. She was looking for a button that would "reset" the calculator. She ended up exiting the calculator and needed guidance to get back to the page.

4.1.2 Questionnaire

For this part, the participants were asked to rate five questions from 1-5 and was asked the reason behind the answer.

The first question was how they liked the calculator. Here P1 answered 4/5. She followed up with that she liked the calculator, but the order of the nutrients were to confusing. P2 gave it a 5/5. She liked the calculator very much, although there were some small problems that needed to be fixed.

The next question was about the usability, and here both answered 4/5. P1 said it was easy to use, and clear on how to operate the calculator, especially because it was her first time seeing it. The only problem again was the order. P2 said that the reason for not giving the highest score was because it was unclear to her how she could add a new product. She also said she would like a save function for the product that had been tested, such as converting the result to a PDF file.

The third question was how useful the calculator is. Here P1 answered 5/5. The reason was because it was easy to use and efficient. P1 said " *I have calculated for*

"Nøkkelhullet" before, and then I have worked with long and crazy spread sheets in excel, so this calculator is heaven compared to that". P2 also answered 5/5. She said that for her personally it is closer to a 2/5 because she has worked a lot with the requirements for the keyhole. P2 said that she couldsee if a product meets the requirements or not by only looking at the nutrients list. However, she does thinks this calculator can be very useful for people that are new to the requirements for "Nøkkelhullet", as well as their suppliers. For that reason, she gave the question a high score.

The next question was about the design. Both answered 4/5, and the main reason for this was how the order of the nutrients was listed. P2 said "*The risk of typos increases if it is not listed in the same order that is used officially*". She also stated that the arrows in the drop-down menus were too bright and had some trouble knowing where to click. She also said that the button for calculating the product should be changed. It should not say "søk"(search), but "beregn"(calculate). She said "*Some labeling schemas, we need to apply(search) to before we can use them. And the keyhole is a labeling that only calculates if it meets the requirements, we are not applying to anything here, only calculating"*.

The last question was if they could see them self's use the calculator in the future. Here P1 answered 3/5, and the reason was because it is their suppliers that mainly work with this and are in charge of putting up the nutrients list, and they send that back to us. However, she said it could be a helpful tool to check if everything is correct. P2 on the other hand, answered 5/5 and the reason was because, she thinks this could be a great tool to use, "*when I am speaking to a supplier, I could show by varying the content of fish in a recipe and the nutritional content, then I can show which product can get labeled with the keyhole and which cannot.*"

4.1.3 Interview

For the interview five questions were asked, the questions gave some similar answers as that in the questionnaire round. Although the interview did provide more detailed answers.

The first question was what they think of the calculator. P1 said the calculator was user friendly, despite having some bugs in the system that needed to be fixed, and the order of the nutrients should be changed. P1 also added, when the features for nutrition claims and health claims are implemented, the calculator can become a great tool, for many.

P2 thought the calculator was good. However, she thinks that the calculator is too focused on the keyhole, and she would like to see a function that would focus on "Nutri-score" as well. She said that Nutri-score is discussed a lot within the European Union. This labeling scheme might become a regulation in Norway in the future.

The next question was how they liked the design, and here P1 said that the interface is easy to understand, and not too complicated. P1 also liked the way the calculator is displaying the message for the keyhole.*" It is easy to see if the product meets "Nøkkelhullet" and it is also easy to see if it is not meeting the requirements, and it gives a good description as to why".* P2 liked the design as well, and said that the calculator was self-explanatory, and easy to use.

Question three was what they did not like about the calculator, and question four was if they faced any problems using the calculator. Both questions did not present any new answers or thoughts, as this has already been covered.
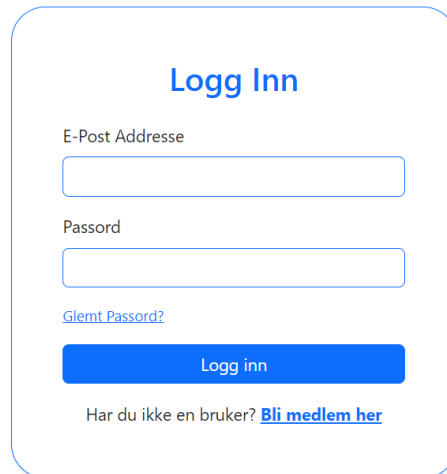
The last question was if they had any tips to the developer for the next version of the calculator. Here P1 answered that she would like the categories for selecting the food groups to be somewhat more understandable. "*The is a lot of text in some of the categories, and it can be a bit confusing, but then again these are gathered from the regulations, so maybe all the text is needed after all*". As for P2, she had nothing else to add.

4.1.4   Interview for login page

The final part of the usability testing was for the participants to look at and evaluate two different login proposals.

For the first two design proposals the plan was to create two forms that was completely different from one another. The first proposal is minimalistic and simple,

whereas the second one is more elaborate, with more colors and the use of a full screen background image, (see Figure 4-2 for proposal 1, and Figure 4-3 for proposal 2). By doing this it can give a better understanding of what the participants want in a login page. Would they be drawn to a simplistic and standard design, or would they prefer a design with more elements, and colors.

Figure 4-2. Design Proposal 1 for the login, shown in iteration one. Using a simplistic style

Figure 4-3. Design proposal 2 for the login, shown in iteration one. Using an elaborate design.

The participants were asked to look at both design proposals and tell which one they liked the most. P1 liked design proposal 1 the most. She thought that the form had a good size, it was simple and easy to understand. However, she would like for proposal 1 to show Fremtidsmat's logo, to let her know she is on their page. She also mentioned that the design was a bit boring to look at.

P2 also liked proposal 1 the most. She said that the first proposal was clean and easy to understand. She too would like to see Fremtidsmat's logo be added to proposal 1.

For the second design proposal, P1 thought that the design was too much. The background image was the biggest issue. P1 thought it was to disturbing, and she did not like the sugar snap peas illustrated on the image. By using a different background image, it could have been a lot better, she said. P2 thought that the second proposal was too much of everything. She thinks that the login box, was too small compared to the rest of the page, but she did like that Fremtidsmat's logo was utilized on that design. "*If you put Fremtidsmat's logo from proposal 2 on proposal 1, I think the first design will be good*".

Both participants liked that the login forms used email as the identifier, and not username. They both think usernames are annoying, and difficult to remember.

4.2 Iteration 2

For the second iteration, one participant(P3) was able to take part in the usability testing. P3, who also were the spokesperson for setting up the meeting, were asked if she could find one more participant from company B, to take part in the usability testing. Unfortunately, due to little availability from her coworkers, P3 could not find a second person.

Nevertheless, the usability testing was still carried out. P3 had previously tested the calculator during the early stages and knew the concept of the product well.

4.2.1   Testing Tasks

For the testing tasks P3 used around 10-15 minutes to complete all the tasks. P3 experienced some difficulties using the calculator the first time but understood quickly how the navigation worked. The problem she faced was finding the right food category.

The first product that she tested was "Gilde Karbonadedeig". This was a product she was familiar with from before, when it comes to the regulations. When selecting the first food category, a sub-category appears underneath. When accessing that drop-down menu, she had trouble choosing the right category. As seen on the figure 4-4, she hovered over category number 24. From her previous encounters with that regulation, she knew that category 24 had three options called 24 a, 24 b, and 24 c. For this reason, she was not comfortable selecting the category, in case it was wrong. After asking the interviewer for guidance, she was told to select the category and see what happens. When pressed, she could see that an additional subcategory popped up, showing alterative 24 a, b, and c (Figure 4-3).

Matkategori

24. Kjøtt og produkter som inneholder kjøtt. Minst 50 % av produktet sk…   ⌄

23. Kjøtt som er uforedlet.

24. Kjøtt og produkter som inneholder kjøtt. Minst 50 % av produktet skal være framstilt av kjøtt, korn (100 % fullkorn), grønnsaker (unntatt poteter), belgvekster (unntatt peanøtter) eller rotfrukter. Innholdet av kjøtt skal likevel være minst 20 % av produktet. Dette gjelder ikke for leverpostei som skal inneholde minst 35 % kjøtt. Produktet kan inneholde saus eller lake. Prosentandelen og vilkårene gjelder for den delen av produktet som er beregnet til å spise. Produktet kan være panert, hvis tilberedningen ifølge produsentens anvisning, ikke tilfører produktet fett.

Figure 4-4. Showing the food category nr 24. Only two options in the dropdown menu, 23, and 24.
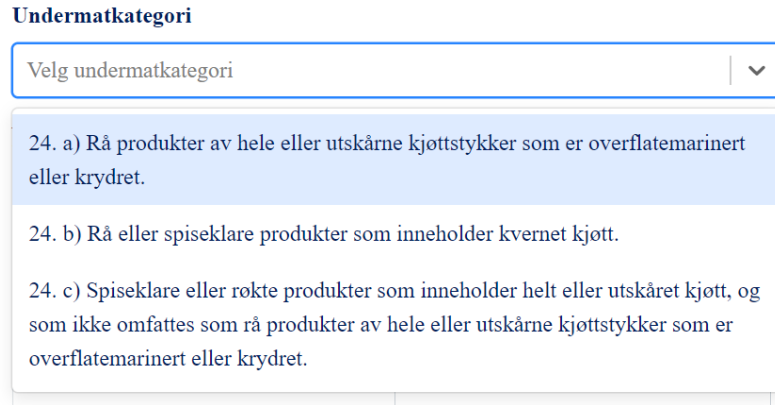
Figure 4-5. When category 24 is pressed, this sub-category appears, containing 24A, B, and C.

After discovering this she had no other problems using the calculator, and the sub-categories was clearer and easier to understand.

Based on the feedback from iteration one, three new buttons were implemented, "save product", "share product", and "add new product". They were placed underneath the health claims box. The first two buttons have no functionality and only works as an indication for future development. The button "add new product" will reset the calculator, and a new product can be added. The buttons can be seen on Figure 4-6.

When P3 was supposed to add a new product, she did not notice the buttons. She scrolled to the top of the page, resulting in the buttons to disappear. Because of this she struggled to reset the page, and needed to ask the interviewer again, on how she could add a new product.

Figure 4-6. Showing the three added buttons at the bottom of the calculator.

After clarifying the two issues, P3 had no further difficulties using the calculator. She did however point out a problem with the new function for nutrition claims. The nutrition claims function at this time only worked on one food category, "vegetables, root vegetables and legumes". In addition, the only claim that that was implemented was "without added sugar". So one testing task she was given were to test the vegetable "spinach". The results showed that spinach met the requirement for the nutrition claim "without added sugar".

  When the results showed, she did not agree. The reason was because that nutrition claim could not be used on vegetables. She said, "*It is not a legal claim to use without added sugar on spinach".* This is a misleading claim as there is not added any sugars on a regular vegetable product.

4.2.2   Questionnaire

On the first question, if she liked the calculator, she answered 3/5. The reason she gave it a 3 was, because the new function for nutrition claims, did not include other nutrients. By having more nutrients, it would increase the utility value for the calculator. She also mentioned that the nutrition claim that was proposed could not be used as well. She added "*If a person is to use this calculator as it is now, they*

need to know the regulations well, because if they don't, a huge mistake could be made, if they trust the outcome completely".

On the next question, for the usability she answered 4/5. She liked the usability, and the only thing that she would like to see different is to make the button for adding a new product clearer. Perhaps move it to the top of the screen, or at least make it easier to find.

The third question was how she liked the function for nutrition claims. She had already mentioned that the function needs more improvements, and that there were some problems with it, but she gave the rating 4/5. The reason why she gave such a high score, despite finding problems, is because she really likes the idea, and with further development it could be a great tool and hold a huge beneficial value.

The next question was how useful she thinks the calculator is. She answered 3/5. She thinks that the calculator would be more useful if it included more nutrients, such as iron, vitamins, iodine, etc. She also thinks that the calculator needs to show the right nutrition claim before she could give a higher score.

For the design she rated the calculator 5/5. She thought that the design was nice, and easy to use, and had nothing else to add.

For the last question, she was asked to rate how likely she is to use the calculator in the future. Here she answered 5/5. The reason was because she sees the potential in the calculator. When the calculator is finished, it could be a great tool for double checking the keyhole and see potential nutrition claims.

4.2.3 Interview

The first question was what she thinks of the calculator. The participant answered that she likes the design, as well as the idea for the calculator. It can simplify the workload considerably, especially if it can provide more nutrition claims then now. She also said that the persons that most likely would use this calculator, are not that familiar with the regulations, so it is important to make sure that every result that is shown are 100% correct.

The next question was about her opinion on the design. As she had stated earlier, it is nice and simple, and no unnecessary information.

The third question was how well she liked the function for nutrition claims. She likes that the function is included in the calculator, she likes the thought of a calculator that can give you the answer, without having to read through all the regulations. However, as mentioned earlier she would like to see more nutrients, and only show nutrition claims that can be used.

The next question was what can be done differently for the nutrition claims. Here she said that she would like an information box that warns the user to double check the results in case the claim is misleading.

For the final question which was if she had any tips for the next round of development, she said focus on adding more nutrition claims. She also mentioned to add a warning box, that tells the user to double check the claims, or to be used on their own responsibility.

4.2.4   Interview for login and welcoming page

For this part two new design proposals and a welcoming page were shown to the participant. Based on the feedback received from the first iteration, the designs for the login page were redone. The feedback showed that proposal 1, where the design was minimalistic and with little disturbing elements was the best option. Showing the logo for Fremtidsmat was also suggested. So, for the new redesigns, the header from Fremtidsmat's webpage was copied and added to the designs. This gives it a more realistic view to the page and makes it easier for the user to know that they are on Fremtidsmat's login page. A similar form was used as the one in the first iteration, but with a slight redesign.

Design proposal 1, as seen on Figure 4-5, shows the header from Fremtidsmat's homepage with the toolbar menu. The login form was placed in the center of the screen, using blue color for the heading, the button, and the forgotten password link. This color is the same blue as used on the toolbar menu in the header. A button for

"show password" was also added in the password input field. According to Tran (2019) having the option for see password, should be available.
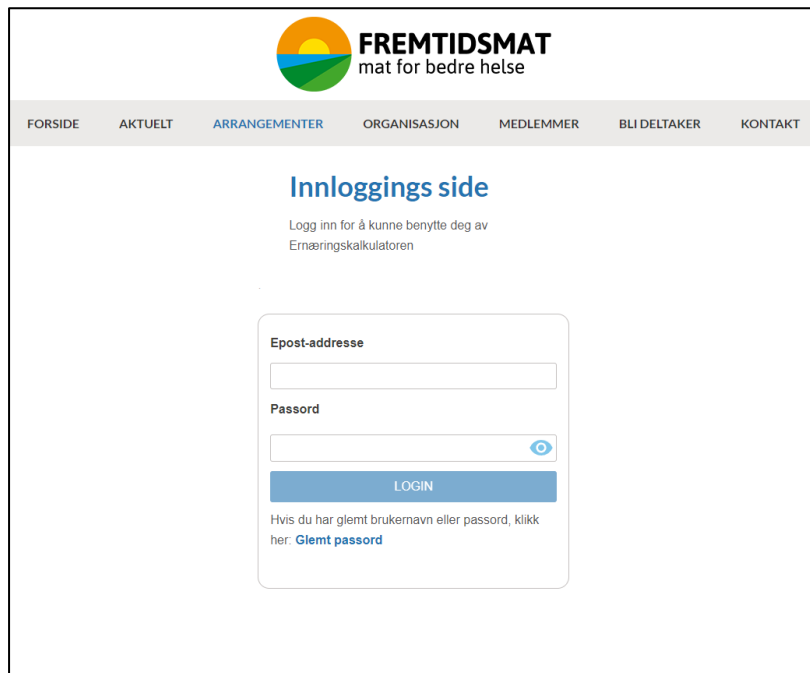
Figure 4-7. The redesign for proposal 1, showed in iteration two.

For design proposal 2, a similar design as the first proposal were used. The difference between the two are that for the second proposal the login form is placed on the left side of the screen. The reason was because according to Yuan et al (2014), the place where the eye quickly locks on to a target is upper left on the screen. So, by placing the login form at the left side, the eyes might be draw directly to the login form. It was also interesting to see what the participants thought of a login form that was not centered, would they have any preference when it comes to placement. An orange color was also used on the header, and in the form. The reason was because it has the same color, as the primary color used in Fremtidsmat's logo. The orange color is the most eye-catching in the logo, and it could give the page a coherent look, Proposal 2 can be seen on Figure 4-8.
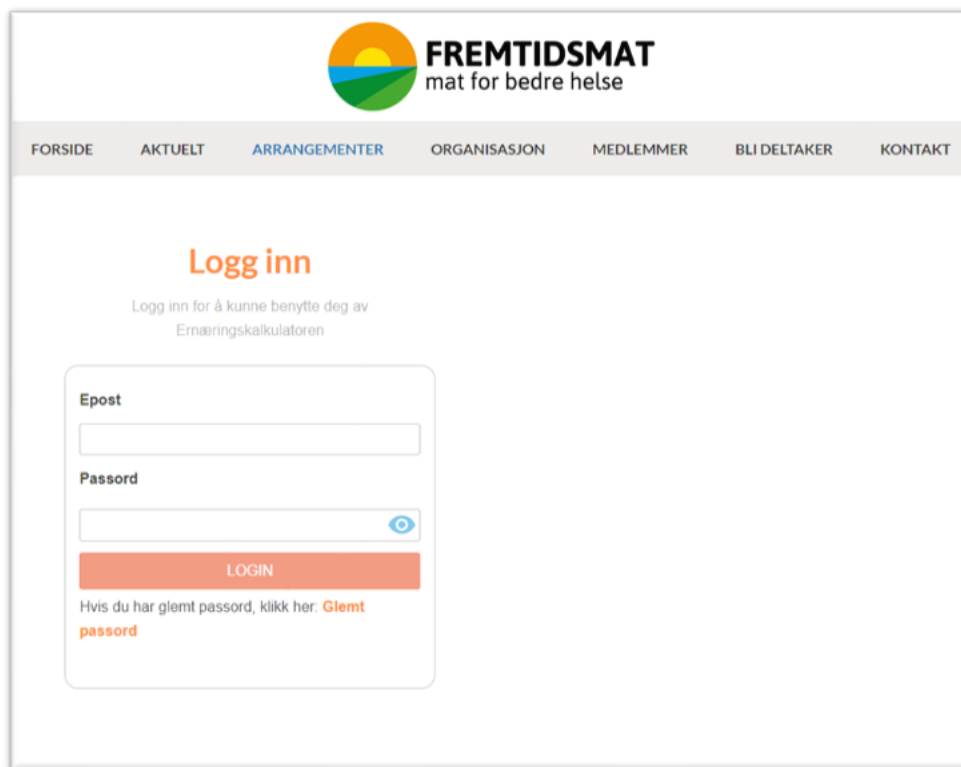
Figure 4-8. Design proposal 2, used in iteration 2. Form is place to the left.

When showing the P3 the two proposals, her favorite of the two where the proposal 1. When asked why she liked the first design more, she mentioned the golden ratio. She liked it better because the form is centered. She thought it looked better in the middle rather than to the left. She said "*I do not know why I like it better in the middle, it is probably because this is how we are used to see things".* She also mentioned that she liked the blue color, more than the orange. She felt that the orange color resembled red, and therefore she felt that she had done something wrong. The blue felt more natural to use for a login page. "*The blue feel more correct, it indicates that you have not started yet, and this is where you log in. The color can turn red if I do a mistake".*

The first proposal was the clear favorite of the two. When asked what she did not like about the proposal 1, she mentioned that it might be a little boring. *"It could be beneficial to add a picture, that could tell more about what this is".*

For the welcoming page, the goal was to make it as simple as possible. The way it was done was by using the source code for Fremtidsmat's home page. From the home page an additional section was made, only visible for a user that is logged in. The information displayed is this section is a welcoming text with the name of the user such as "Welcome John Appleseed". Underneath the user's name there is a short paragraph that explains to the user how to access the calculator. By pressing the button, which is placed under the paragraph, the calculator will be accessed. Another detail that is added is, "Logget inn" on the toolbar menu. This is to let the users know they are logged in. (Highlighted with a red marker on Figure 4-9). By keeping it simple, and easy to understand the user do not have to spend a lot of time looking for the calculator. It makes the experience of using the website more pleasant, as it gets straight to the point, without any fancy elements, or functions (Figure 4-9).
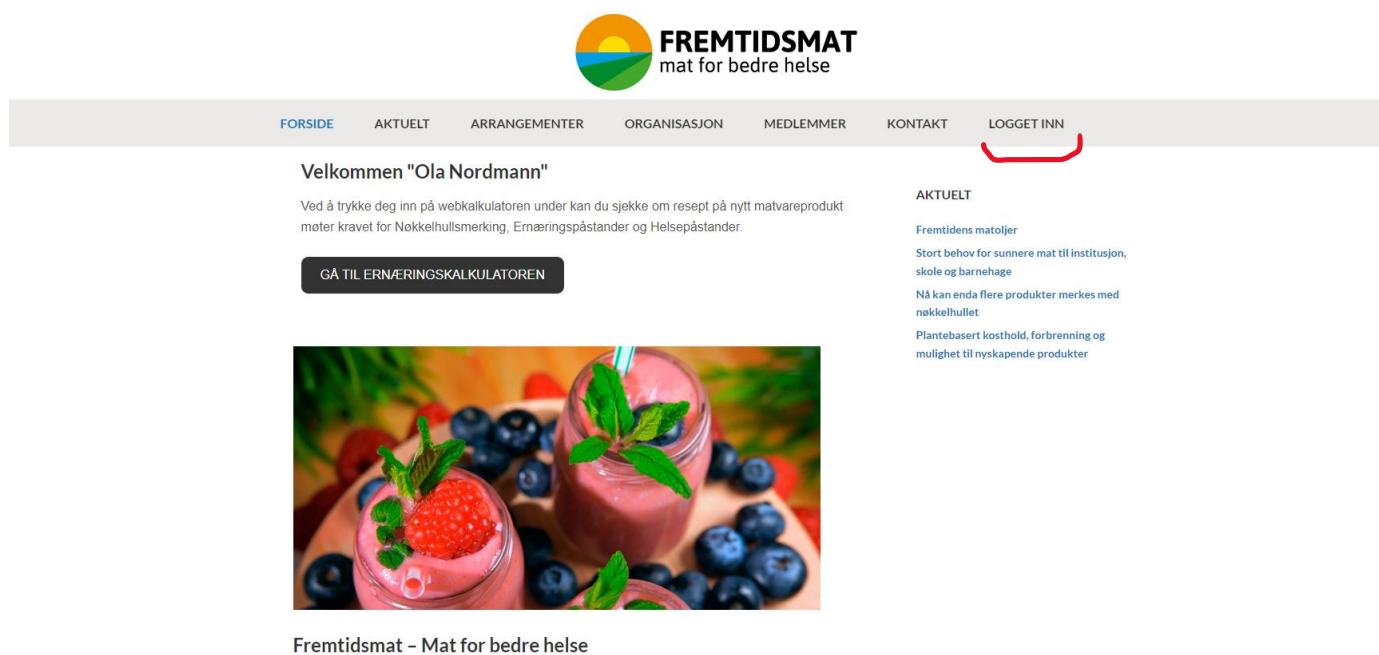
Figure 4-9. The proposal for the welcoming page, shown in iteration two. A red line is added on the figure, to highlight where the user can see they are logged in.

After showing the proposals for the login page, the welcoming page were then shown. After looking at the proposal the participant, said that she liked the page. It was nice and simple and did the job by showing clearly where she could access the calculator. When asked what could be done differently, she mentioned to change the

color of the button to a blue color, as the one used on the login page. She also mentioned that she would like to have a separate page in the toolbar menu where she could get more information about the calculator. How it works, what it does, and present limitations the calculator may be facing at this stage.

4.3 Iteration 3

In this iteration the same participant from iteration two was used (P3). Since iteration two, a second nutrition claim was added, "No added sugars". In addition, both claims work on every food category. A color coding system was also implemented. When both claims can be used, a green-blue color show. When one claim can be used an orange color shows, and if both claims cannot be used a red color show.

4.3.1   Testing Tasks

Since P3 took part in the usability testing in iteration two, the tasks were directed more towards the nutrition claims. There was no need to test P3 on Nøkkelhullet, as she was familiar with how it worked.

The first task that was given to P3 was to add a product that meets the nutrition claim "low on sugar". She used the nutrients for "turkey bacon" (Results shown in Figure 4-10). When the participant calculated the results, she referred to the same problem that occurred in the previous testing. The problem was that for turkey bacon the claim "low on sugar" could not be used, as this is a misleading claim.
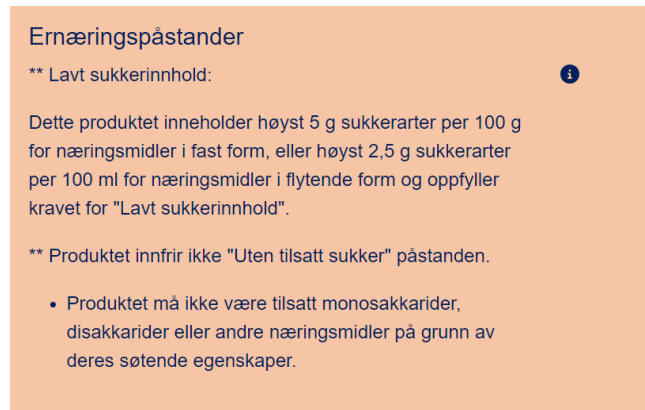
Figure 4-10. Showing the nutrition claim box where only the claim "low on sugar" is usable (Orange color).

The next task, was to add a product that meets both claims (Figure 4-11), and here the product that was used was "raspberry jell without sugar". Here she found no issues and she had no problem understanding what claim could be used. She also agreed that the claim could be used on this product.
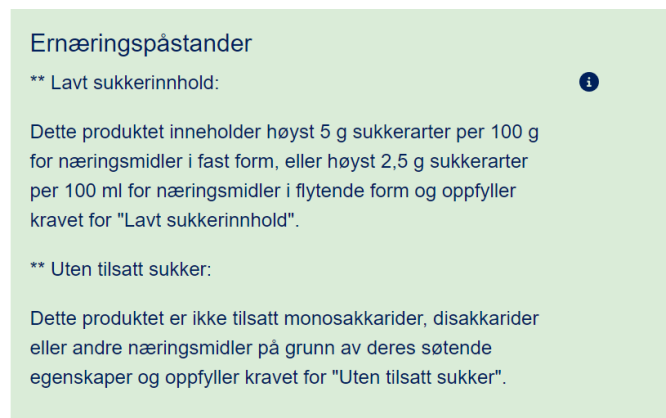
Figure 4-11. Showing the box for nutrition claims when both claims can be used (Light blue/green color).

The last task P3 was given, was to add a product that does not comply to any of the nutrition claims (Figure 4-12). She mentioned that it was not necessary to show the claims that cannot be used. Because when more claims is added to the calculator, the list that comes up will be long. By showing every claims that can be used, and the ones that cannot, it might get confusing, and unclear. The participant proposed a

button that can be clicked to show the claims that can not be used. In that way it is possible to split them from one another.
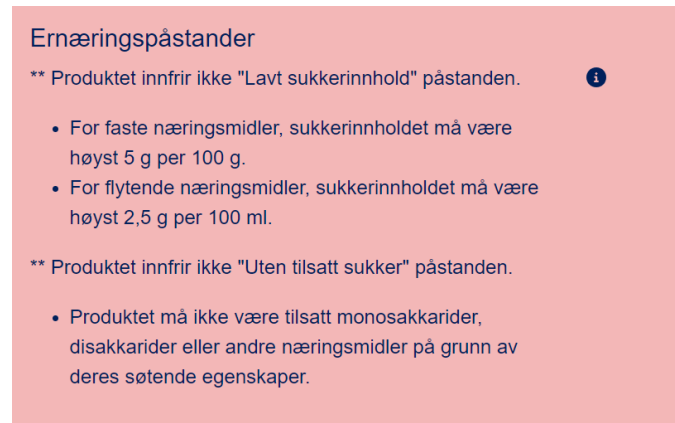
Figure 4-12. Showing the box for Nutrition claims, where no claim meets the requirement (Red color) .

4.3.2 Questionnaire

On the first question, how she liked the calculator, P3 answered 3/5. This was the same score she gave in iteration two, and the reason she gave it a 3, is because the nutrition claims function produced wrongful claims, and that the calculator is missing the possibility to check for other nutrition claims such as iron, vitamins, iodin, etc. She also thinks that is might be too confusing by showing the claims that cannot be used, she would only like to see the ones that can be used.

The second question was about the usability of the calculator, here she answered 4/5, which is the same as last time. No additional comments were added here.

The third question was how well they liked the function for Nutrition claims. Here she answered 3/5, dropping from 4 which she answered in iteration two. The reason why she went down one number is because she is worried about getting nutrition claims that cannot be used. This means that only professionals in the field could use the calculator.

The fourth question was how well she liked the explanation for each claim in the Nutrition claims box. Here she answered 4/5. She liked that it gave an explanation as to why a claim can be used, and why a claim cannot be used.

The last question was how well she liked the design of the calculator, and here she answered 4/5. This is a drop from last time, as she then gave it a 5/5. She said that she could have easily answered 5, and that there was no apparent reason why she answered 4 instead of 5.

4.3.3   Interview

The first question was about their updated view on the new version of the calculator. Here the participant said that she still liked the calculator, and that it has a great potential when the development is finished. However, there are some issues that needs to be addressed, such as the use of wrong claims, and not show the claims that cannot be used, for a product.

The second question was what she thinks about the design, and if it has improved from the last time, or if she likes it less now. The response was that she likes the design just as much now as she did the last time, and that she like the red/pink color, which indicates that no claim can be used.

The next question was about the color coding of the three possible outcomes in nutrition claims. She answered that the color coding is alright, but she would much rather have the claims that can be used, in green, and then ones that cannot be used marked in red. This way it is easier to see which claim meets the requirement, instead of the orange color that indicates that one of the two claims are usable.

For the next question, she was asked if Nutrition claioms is more or less understandable than the last version. Here she answered that she understood it last time and had no problem understanding it now.

For the fifth question she was asked what her thoughts on the buttons. This time using the calculator she remembered that the button for adding a new product was placed at the bottom of the page, and therefore knew where to look for the button. This was unclear the first time using the calculator. She thinks it could be a good idea to switch the position for "save product" and "add a new product". She said it could make it easier to find the button, and she thinks as of now "add a new product" is the

most important button, and it should be first. Another point she had was to change the color from gray (Figure 4-13), to make the buttons more visible for the users.

At this point she was shown a prepared design proposal where the color of the buttons was changed to purple (Figure 4-14) and were asked which one she liked the most. She did like the purple color more as it now becomes more visible, and easier to find. The last comment she added was to change the name for the button "share product". The reason is because it reminds her of a button for sharing on Facebook, and not for converting the outcome to a PDF file, which is the point of this button.

Figure 4-13. Showing the current color of the buttons which is grey.

Figure 4-14. Showing the proposal for using purple color on the buttons.

The last question she was asked was what changes should be done for the next version. Here she said that the color code for nutrition claims should change to only green and red, change the button name on "share product", change the color of the buttons, and add a "waring sign" on the nutrition claims. She said that by adding a warning sign, or a text that lets the users know that a claim might be false, and that they should double check if the claim can actually be used.

4.3.4   Interview for login and welcoming page

For this iteration, the feedback collected from iteration two was used to create a new design proposal. As P3 liked the first proposal in iteration two, this design was left untouched, and stayed the. The second proposal were changed, based on the feedback. For the second design the orange color of the text, and button was replaced with the same blue color as proposal 1. The login form stayed on the left side of the screen, and in addition a picture was added on the right side. The picture shows different foods and has a colorful theme. Shadowing was also added to the border of the picture and the login form. The updated proposal 2 can be seen in Figure 4-15 below.

Figure 4-15. Showing the login page for proposal 2 in iteration three.

When asked which proposal she likes the most, she answered that she liked proposal 1 more this time as well. She believes it has something to do with the placement of the box. She does prefer that the login form is placed in the middle of the screen. She mentioned that the picture in the proposal 2, took most of the focus, as the colors was too strong, and dominant. She did not like that the picture was the same size as the login form, and that using a less dominant picture could help.

Another thing that could be done is by using the picture as a background behind the login form and put them both in the center.

She still thinks that proposal 1 is somewhat boring and that it needs something else added to it, such as brighter colors, or something in the background to make it more interesting to look at.

For the welcome page, some small changes were made to the proposed design based on the feedback received in iteration two. The color of the button was changed to the same blue color used throughout the page, and in the login form. In addition, an option in the toolbar menu was added called "Ernæringskalkulatoren". This was made to indicate to the user that there will be a separate page where the users can read and learn more about the calculator. A new paragraph was also added to let the users know that they can read more about the calculator by following the highlighted link or access it through the toolbar menu. Figure 4-16 shows the new proposed design.

Figure 4-16. The design proposal for the welcoming page, in iteration three.

The first thing she pointed out was to use the same name throughout. In the first paragraph the word "web calculator" is used, but it is better to always call it "Ernæringskalkulator". In the second paragraph, she was confused because it says "access the "Ernæringskalkulator" in the menu at the top. However, the button below says, "go to the Ernæringskalkulator". She thinks that the welcoming page would be better if the text is paraphrased in a better way, to make it easier to understand where to access the calculator, and where the user can read more about the calculator.

4.4 Iteration 4

Iteration four consisted of four usability testing. P4 from company C, P5 from company D, and P1 and P2 from company A. The usability testing on P4 and P5 happened on the same day, and they were both conducted online. This happened just three days after the usability testing in iteration three with P3. For that reason, time was limited, and the only improvement on the calculator was changing the color of the three buttons to blue.

The first usability testing in iteration four was with P4.

4.4.1 Testing Tasks

P4 began the usability testing, by adding the nutrients for "Turkey bacon". The calculator showed that it meets the requirements for Nøkkelhullet and the nutrition claim "low on sugar". The first comment she had, was related to if this claim could be used on bacon. She questioned the relevance, and that it could be misleading.

When she was asked to add a new product, she was not sure if she should press the button for "save product" or "add new product", but after some thinking she came to the conclusion "add new product".

For the rest of the tasks, she had no problem using the calculator, or understanding what to do.

4.4.2 Questionnaire

In previous iterations the participants were asked to justify their rating with a follow up answer. From this point forward this was dropped due to receiving the same answers in the follow up interviews.

For the questionnaire, P4 gave the following answers:

How well do you like the calculator – she answered 5/5.

What do you think of the usability - She answered 5/5.

How well did you liked the function for nutrition claims - She answered 5/5.

How well did you liked the explanations given in the nutrition claims - She answered 5/5.

What do you think of the design - She answered 5/5.

How useful do you think this calculator is - She said, "*Super Useful*", and gave 5/5.

Do you see yourself use this calculator in the future – She answered 5/5.

P4 rated 5/5 on every question, and she added that she was quite generous on the rating. She said the reason was because she really liked the calculator, and she wanted to use the calculator as soon as possible.

4.4.3   Interview

For the first question, the participant was asked what she thinks of the calculator. Here she answered that she really liked it. She thinks it is a useful tool that is great for evaluating the different nutrition claims. However, there is that issue with if the claim can be used or not. She also wants to see it work for other nutrients such as vitamins, iodin, and calcium, etc. She would also like to have some products already stored in a list/database, so that she does not have to type in every product if she wants to check if any claims can be used.

The next question was how she liked the design, and here she said that it was "super". It was easy to use and she no problem understanding how it worked. In addition, she also liked the overall design.

Question three was if she liked the color coding for the nutrition claims box. At first, she thought this was clear, and that it worked great. However, later during the interview she saw it change from red to orange more clearly and wanted to change her answer. As the color changed, she had no idea as to why. It still looks like both is unusable. She does not think that a consumer would understand why it turned to orange, instead of green. Especially if the claim is "No added sugars".

The next question was if she is happy with the explanations given in nutrition claims. Here she answered that it works fine. However, she noted that when the claim "low on sugar" does not meet the requirement, a somewhat confusing sentence showed. The description states: "For solid foods, the added sugars cannot be more than 5 g per 100 g". The problem with this, is that this statement is referring to the carbohydrates field. So, if a product has more than 5 g of carbohydrates, the description will show "added sugars". This makes it confusing, and she said that it should be explained that added sugars, is referred to as carbohydrates in this calculator.

For the next question, she was asked if it could be beneficial to add a second subcategory in carbohydrates called "natural sweetener". The reason is because when filling in the nutrients of a product, such as "Litago sjokolademelk, uten tilsatt sukker" (chocolate milk without added sugar), the claim "without added sugars" will not be triggered in the calculator. However, "Litago" is using that claim. The reason why it does not trigger is because, when adding this product to the calculator, it does not account for the natural occurring sugars in the product. When asked P4 was not sure if this is a good idea. She said, what is natural sweetener, and what can be seen as a natural sweetener? Is it honey, or milk sugar (lactose). By calling the sub-category natural sweetener", users might start to fill in all sorts of nutrients, such as stevia, table sugar, or cane sugar. It might be too confusing for the user.

For the next question she was told that this calculator at this stage, gives out both claims for all products that contain less than 5 g of carbohydrates, and if added sugars equals 0 g. On some products such as vegetables these claims cannot be used, even though carbohydrates is less than 5 g, and added sugars is 0 g. This would be misleading for the consumers, and it is a false claim. So, the question was if she would like a warning symbol, or a text that warns the users to be careful trusting the results. If so, where would it be best to place such symbol or text? P3 thought it was a great idea. Because the users should be warned that if a claim is met on this calculator, it does not necessarily mean that it is usable. As for the placement she would like to place it at the top of the screen, in the vacant space over the keyhole (Figure 4-17). She would not place it at the bottom of the screen, as it could easily be missed.

Figure 4-17 Showing the vacant place P4 would place the warning text.

The next question was if the buttons at the bottom of the screen is understandable, and if she sees what each button is representing. To this, she said that they all looked clear, and told correctly what the intentions were for each button.

For the next question she was asked if there is anything that can be done differently on nutrition claims. Here she could not think of anything else besides what she had already mentioned.

The last question was what we should focus on for the next version. Here she answered, when you get a nutrition claim, the sentence is formulated in a strict way. The claim should not give room for any interpretations. But if there are any claims that can have multiple variations, it would be helpful to see all the possible variations. She said that many people find it difficult to use nutrition claims because they must be very specific.

4.4.4 Interview for login and welcoming page

The participant was shown the same two design proposals for the login, as the ones shown in iteration three. When asked which she liked the most, she answered proposal 2. She did like the addition of the picture. She would however, change the picture to one that shows the whole span of food products. Not just vegetables, but

also include meat, fish, and dairy products. She said the reason is because that this picture gives the impression that this is the only healthy foods that someone can eat. She would also like to see a more relevant picture, and something that is more descriptive, as this is a login page for a calculator.

P3 did not mind that the login form was placed on the left side of the screen, and thinks it looks great, besides changing the picture. For proposal 1 she said it could be an idea to add a picture there as well. She would like to add a picture and place it in the background behind the login form.

As for the welcoming page, she did like it. It was short and understandable and gave the information that was needed. She also said that she liked the layout and had no additional inputs on improving the design.

4.4.5 Iteration 4, second usability testing

This usability testing consisted of one participant (P5) and the usability testing was conducted online.

4.4.6 Testing Tasks

When testing the calculator, P5 first mentioned that the food categories contained to much text. P5 said she was not interested in reading all the text that was presented and was looking for keywords to help choose the categories. However, she did mention that all the text might need to be presented in order to find the right categories, as there are many similar categories that look alike.

When she was asked to add a new product, P5 did not know how to reset the calculator. She scrolled to the top of the page and pressed Fremtidsmat's logo that sent her to a different page. From this page she was able to find the way back to the calculator. After completing the next testing task she used the refresh button on the browser to reset the calculator. For the last product she was told that there is a button at the bottom that can refresh the calculator. When discovering this, she said that the "Microsoft Teams window" was placed over the add a new product button, and that

was the reason she did not see it. After finding this out she had no problem using the calculator for the remaining tasks.

4.4.7 Questionnaire

For the questionnaire, P5 gave the following answers:

How well do you like the calculator – she answered 4/5.

What do you think of the usability - She answered 4/5.

How well did you liked the function for nutrition claims - She answered 5/5.

How well did you liked the explanations given in the nutrition claims - She answered 4/5.

What do you think of the design - She answered 4/5.

How useful do you think this calculator is - She answered 4/5.

Do you see yourself use this calculator in the future – She answered 4/5.

4.4.8 Interview

The first question that she was asked was, what she thinks about calculator. She said that she liked it a lot, and it has a great potential. She thinks that this calculator could be very useful for smaller companies that might not have the capacity to go over all the regulations, and it could make the jobs easier for them.

When asked about the design, she thinks that it was great. It was easy to use, and easy to understand. She mentioned that if a product does not meet the requirement for "Nøkkelhullet", it was a great touch to highlight the nutrients that was too high.

When asked if she understood the meaning of each button, she did get somewhat confused. The reason is because both "save product" and "add new product", could potentially mean the same thing. When pushing the save product button she believes that a popup message would show, and say "product saved" and the calculator would be refreshed. For the add a new product button, she would rather call it "reset" or "refresh", as it would be easier to understand.

The next question was what she thinks about the color coding for the three different options in Nutrition claims. At the beginning she was somewhat confused, and that was mostly due to the orange color that indicates one claim can be used. The reason was because she spent some time finding out which of the two could be used. On the claim "low on sugar", it says on the last sentence in the text, that it meets the requirements. This should be shown more clearly, so that one can see that the requirement is met on the first glance. If it is easier to see if the claim can be used, the orange color could make more sense, the participant added.

When asked if the participant is pleased with the explanations given in Nutrition claims, she mentioned a problem with the wording. When the claim "low on sugar" is met. The description states that a product cannot have more than 5 g of "added sugars" pr 100 g. However, this statement is referring to the carbohydrates field. That is why she would like to change the sentence to "5 g of carbohydrates pr 100 g". It is important to use the same terminology, so it does not confuse the user, she said.

For the next question she was asked if she would like to have a warning symbol, or a text that warns the users to be careful trusting the results. If so, where would it be best to place such symbol or text? She thinks that this is a good idea, and it is important to let the users know about this issue. She would place a warning symbol right beside the claim so that it can be visible, and easy to spot right away. When pressing the symbol, a descripting of the issue should popup.

For the next question, she was asked if it could be beneficial to add a second subcategory in carbohydrates. P3 agreed and thought it could be a good idea to add another category, however the naming on this category needs to be precise. She could not think of a good name for this category but mentioned "hvorav sukkerarter" in addition to the existing "hvorav tilsatte sukkerarter" category.

The next question was if she had any comments on what could be done differently for nutrition claims. Here she answered that it could help to remove some of the text, as she believes it is too much. In addition, she mentioned to add bold characters to the sentence, when a claim can be used. To make it clearer if the claim can be used or not.

When asked what she did not like about the calculator she mentioned that there are too much text in food categories, and she had no other comment beside that.

She was also asked it she had any technical problems when using the calculator. She answered that she did not have any technical problems using it.

The last question was if she liked the new blue colors of the buttons, and to this she liked the color, and thought is matched the theme for the rest of the page.

4.4.9　　　Interview for the login and welcoming page

P5 was also shown the same two design proposals as the ones in iteration three. When asked which she liked the most, she answered proposal 2. She liked this one more because it had a more visual feeling to it with the picture. She also liked that it showed less text than proposal 1. The header in proposal 1 says "innloggings side", and proposal 2 says "logg inn". In addition for the email field, in proposal 1 there is a typo, "Epost-Addresse", there is only one d. She likes that proposal 2 only shows "Epost". "*Proposal 2 is more strait to the point, then proposal 1, and that is why I like it more",* She said.

She was asked what she thinks about the picture that is shown on proposal 2. To this she answered that she likes it, she believes she has seen the same, or a similar picture often being used and associated with nutrition. This helps her visualize that she is on a page, where the content is related to nutrition. However, she would like to turn down the contrast for the picture, as it might be too bright, and takes too much of the focus. It could also be placed as a background image behind the login form. If the form is placed in the center, and have the picture behind it, it might be better. She does think that it is better to have the form in the center, as it would be easier on the eye as well.

For the welcoming page she was also shown the same proposal as in iteration three. When asked what she thinks of the page, she answered that she liked it. It was easy to understand, and she felt that the information was clear, and straight to the point. She did however, mention the slideshow of the pictures, below the added section. This slideshow is used on Fremtidsmat's actual page and was not developed for this

welcoming page. She thinks that it would be enough to only show one picture, as the slideshow took too much focus.

When asked if there is something that could be done differently for this page, she did not have any comment, besides the fact that it could have been a bit more entertaining. But she thinks that the design is coherent with the rest of the page, and it is implemented in a good way.

4.4.10   Iteration 4, third usability testing

This was the final usability testing for this thesis. For the last usability testing, the same two participants from iteration one was contacted (P1 and P2). Due to a schedule error, P1 had only 20 minutes available for the test. Because of this some of the questions were skipped in the interview section and some of the answers were not that detailed.

4.4.11   Testing Tasks

P1 began with the testing tasks. After choosing the first food category, she forgot that there were additional subcategories that needed to be selected before calculating the results. Because of this, it did not work, and she had to do it over again. When she noticed the mistake, she blamed herself and not the calculator, as she was going too fast. For the remaining tasks, she had no additional problem using, or understanding the calculator.

For P2 she had no trouble completing the tasks, she noticed that "add a new product" button was added, as she suggested in iteration one. P2 did wonder what the two stars (Figure 4-19) that was placed before the claims meant. She thought the stars referred to "read more" and looked around the page for a footnote.

** Lavt sukkerinnhold:

Figure 4-18. The two stars before the nutrition claim.

4.4.12 Questionnaire

For the questionnaire, P1 gave the following answers:

How well do you like the calculator – She answered 4/5.

What do you think of the usability - She answered 4/5.

How well did you liked the function for nutrition claims - She answered 4/5.

How well you like the explanations given in the nutrition claims - She answered 4/5.

And what to you think of the design - She answered 4/5.

As for P2 she answered the following:

How well do you like the calculator – she answered 4/5.

What do you think of the usability - She answered 4/5.

How well did you like the function for nutrition claims - She answered 3/5.

How well did you like the explanations given in the nutrition claims - She answered 3/5.

And what do you think of the design - She answered 4/5.

4.4.13 Interview

The first question that was asked was what they think of the new version of the calculator. To this P1 said that she saw clear improvements, and she liked the addition of nutrition claims. She also mentioned that the feedback from iteration one that they gave had been worked upon, and fixed. P2 thought that it was exciting. She thinks that the function for nutrition claims is a great addition.

When asked what they think of the design. P1 said that it was clear, and easy to use. She had no other comments besides that. The same for P2, she did like the design. It has not changed much since the last time, which is a good thing. It is nice, clean and easy to use.

For the next question, they were asked what they think of the color codes used in the nutrition claims. P1 thinks that this solution is a bit unclear. The color is too close to red, and it seems like both are wrong. It reminded her of a traffic light, and said it can work that way, but the colors need to change to, green, a clearer yellow, and red.

For P2, she also thinks the color code looks like a traffic light. However, she did find it confusing. The red and the orange color is too similar, so for a new user they might think both claims are wrong because of the orange being too close to red.

The next question was if they are pleased with the explanations given in nutrition claims. Here P1, liked the explanation. She liked that it included the reason for why or why not a claim is met, and that it was easy to see which claim can be used. P2 on the other hand was not that pleased with the explanation. She thinks it needs to be clearer if a claim can be used. Have it say on the first line, "low on sugar can be used". Show it clearly and be consistent with the wording. One place it says "innfrir" and another place it says "oppfyller", (two different meanings for fulfills).

For the next question, they were asked if it could be beneficial to add a new subcategory under carbohydrates. To this P1 said that the nutrients list should be put up according to regulations. She thinks that it looks fine as it is. P2 thinks it can be a good idea. However, the name of the new field, needs to match up with "Matvaretabellen". There they use "Starch" and "Mono- and disaccharides" as additional nutrients under carbohydrates. So, maybe add one of the two.

The next question was if they would like a warning button/text, and where they would place it. P1 said that it could be a good idea. Tell the users to think for themselves and be aware. She would place a text between the nutrition claims, and health claims, marked with a symbol, as this would be easy for the users to see. P2 also agreed that this is something that needs to be added. She said to add a link to the regulations besides the nutrition claims, and a note that says "*control check if you can use this claim on this product*". She was shown that if she presses the info button marked with a small "i", it is possible to be directed to the regulations. She would

change that information button to a warning sign, as she said "*You have to be quite eager if you press all the I's that pop on the internet*".

Question eight was if they understood the meaning of the three buttons. Here P1 said that she understood them right away and had no problem knowing what they represent. P2 on the other hand, wanted to change the name of two buttons. The first button should be called "save product to the food database" and the second should be called "convert to PDF".

The next question they were asked was, what can be changed on nutrition claims, to make it better. P1 answered, to add the warning text, and change the orange color, as it looks to red. P2 said to add more nutrition claims and had nothing else to say besides what is already mentioned.

Next question was if they encountered any technical issues/ bugs. To this P1, said no. However, she did have trouble with the subcategories, but she did not blame the calculator. P2 said that she did not encounter any technical problems.

For the last question, if they have any tips to what should be focused on in the next version. P1 said to add the warning, and she would like to see more nutrition claims added. P2 also would like to see more claims, but she would rather have two claims that work correctly, then ten that gives false claims.

4.4.14   Interview for login and the welcoming page

For the last version of the designs, some changes was made on both login designs.

For proposal 1, a picture was added in the background behind the login form. The picture is the same as in proposal 2. Adding a picture was one of the most frequent comments for this proposal. The text was also changed from "Innloggings side" to "Logg inn". (See Figure 4-20).
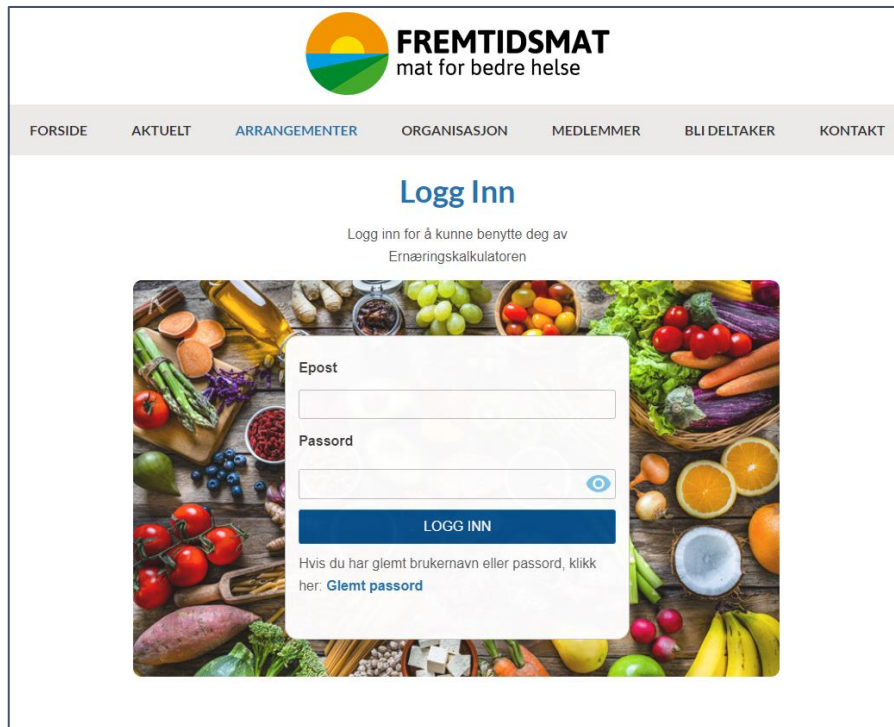
Figure 4-19. Proposal 1, shown to P1, and P2 in the final usability testing.

Proposal 2 did also get a small change. The size of the picture on the right side was changed. Based on feedback, some participants thought it looked weird when the picture was the same size as the login form. By making the picture bigger it fills out the page more (Figure 4-21).
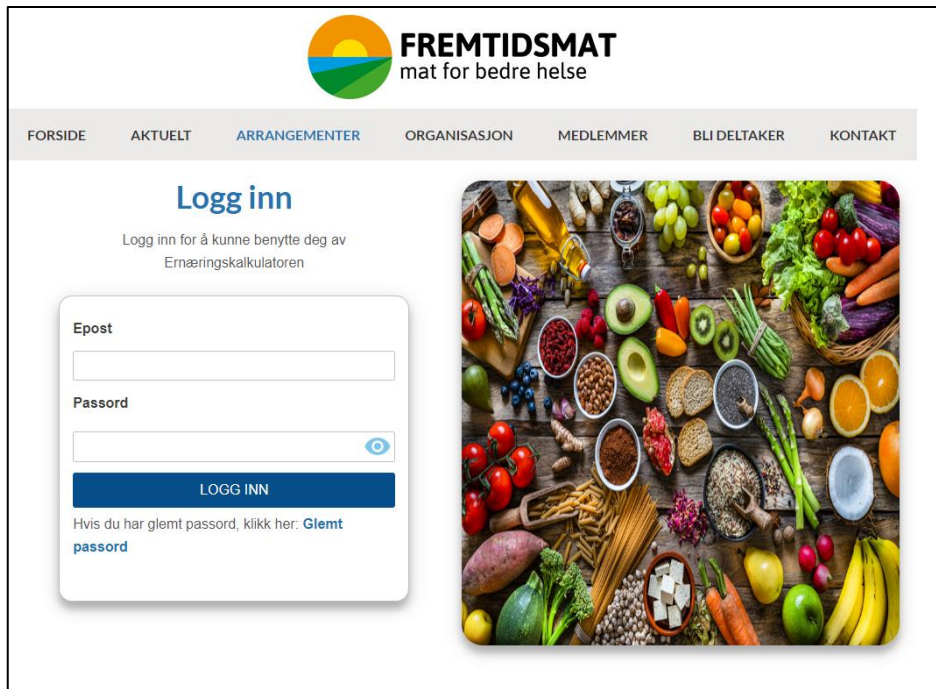
Figure 4-20. Proposal 2, shown in the final usability testing to P1 and P2.

When shown both designs, P1, did take a long time to decide which she liked the most. She said that the login forms have become much better since the first iteration. She thinks that both designs have their advantages. However, she personally likes when the elements are divided from each other. For that reason, with a small margin she liked Proposal 2 most. She thinks that proposal 2 had a little bit cleaner look to it then the first one.

For P2, when looking at proposal 1, she clearly saw the difference from iteration one. She liked the improvements, and it looks more like a complete login page now. Of the two proposals she liked proposal 1 the most. The reason is because it was centered and gets straight to the point. She thinks that proposal 1 a bit more simplistic and effective. She would like for the word "Ernæringspåstander" in in the paragraph to be written in bold letters, so it would be easier to see. She liked the picture that is used, she said it gives "food pleasure", with fresh colors. If proposal 1 did not have a picture she thinks it would be to boring and colorless, so the picture plays a huge part. She thinks that proposal 2, is too crooked and uneven, it did not does not feel natural.

Not many changes were done to the welcoming page, only one sentence was removed, as suggested by a comment from P3 in iteration three.

For the welcoming page, P1 liked the page. She thought that it was understandable and said she would have no problem using the page. She added: "*I have used why more confusing welcoming pages before, so this is no problem at all compared to them*". When asked if she would change anything on the page, she had nothing to add.

P2 liked the proposal as well, however she was a bit confused. Because this proposal is placed on the current home page of Fremtidsmat, it is possible to scroll down and see the rest of home page. She would like to remove any text that is placed under the picture, so it does not get confused with the regular homepage.

4.5 System Usability Scale

In iteration three and four, the participants were asked to answer a System Usability Scale questionnaire. This was originally only meant to be used on the last iteration, but since the only implementation that happened from iteration three to four was the change of color on the buttons, P3's score was added in the calculations. The added change was so insignificant that it would not have influenced the results obtained from P3 even if she had been asked after the modification.

There was in total five participants, that answered the SUS, and the score is calculated based on their answers. To calculate the SUS score, the "System Usability Scale Analysis Toolkit", developed by Blattgerste, et al. (2022), was utilized. This tool takes the data and contextualizes the score and provides a dashboard showing the most important information, such as the SUS study score, adjective, grade, etc. The results from the SUS questionnaire are shown in Table 4-2.

Table 4-2. Results from the SUS score.

Score	Results
SUS Study Score:	85.5
Median:	85
Standard Dev.	3.32
Adjective:	Best Imaginable
Grade:	A
Acceptability:	Acceptable

As seen in Table 4-2 the SUS study score for the calculator is 85.5. According to Sauro (2018), everything over 84,1 is considered "Best imaginable". The average score of a website is 68, meaning the calculator scores much higher than the average website. Due to the high score, the calculator did also receive the grade A+, and on the acceptability score it gets the best score "Acceptable" (Sauro, 2018).

Looking at the individual questions (Table 4-3), the values are normalized values between 0-10. Representing their contribution to the SUS study score and not the Likert scale values in the questionnaire where even numbered questions are formulated negatively. The lowest individual score was 7 (Question 5 and 6). The highest score was 10 (question 7).

Table 4-3. The median score of each question in the SUS questionnaire.

Questions	Mean Score
I think that I would like to use this system frequently.	7,5
I found the system unnecessarily complex.	9
I thought the system was easy to use.	9
I think that I would need the support of a technical person to be able to use this system.	9.5
I found the various functions in this system were well integrated.	7

Questions	Mean Score
I thought there was too much inconsistency in this system.	7
I would imagine that most people would learn to use this system very quickly.	9
I found the system very awkward/ cumbersome to use.	10
I felt very confident using the system.	8.5
I needed to learn a lot of things before I could get going with this system.	9

4.6 Summary questionnaire

The results from the questionnaire using a Likert scale, was added and placed in Table 4-4. It calculates the median of all the question that was asked to the participants. For the participants that has been asked the same question in two iterations, their latest rating is used to calculate the median.

Table 4-4. Individual and median score of each question from the questionnaire. For P1,P2 and P3, their score is based on their latest usability testing.

Questions:	P1 Iteration 4	P2 Iteration 4	P3 Iteration 3	P4 Iteration 4	P5 Iteration 4	Median score
How did you like the calculator?	4	4	3	5	4	**4**
How would you rate the usability of the calculator?	4	4	4	5	4	**4,2**

Questions:	P1 Iteration 4	P2 Iteration 4	P3 Iteration 3	P4 Iteration 4	P5 Iteration 4	Median score
How well did you like the function for Nutrition claims?	4	3	3	5	5	**4**
How well did you like the explanation, given in Nutrition claims	4	3	4	5	4	**4**
How useful do you think the calculator is?	5	5	3	5	4	**4,2**
How do you like the design for the calculator?	4	4	4	5	5	**4,4**
Is this calculator something that you would like to use in the future?	3	5	5	5	4	**4,4**

5. Discussion

In this section, the objective was to analyze and discuss the findings in relation to the research questions that guide this study. Specifically, the aim of this paper was to evaluate the usability of the nutrition calculator. By examining the findings, it is possible to determine how well the calculator is perceived and used by the potential users. In addition, the second part of this study was to create and evaluate a design proposal for a login and welcoming page.

5.1 The nutrition calculator

For this study, there has been conducted eight individual usability testings, and feedback has been gathered from a total of five participants. Since the start of this project, four iterations of the calculator have been evaluated and improved upon.

Based on the feedback from all the participants, it shows that this calculator is sought after tool. On the question "how useful do you think the calculator is" the median is 4.2/5. This is a one-of-a-kind calculator, as there is no other product on the market that can offer the same functions. As seen in the literature review, only one tool, "Essentia" have a function for nutrition claims. This is however restricted to protein. Every participant could see the potential this calculator has, as it can help make their job much easier when labeling products with the keyhole, nutrition claims, and health claims. On the question "is this calculator something that you would like to use in the future", the median was 4.4, further strengthening the value and demand for this calculator.

In most of the testing tasks, the participants were able to identify different problems regarding usability, and functionality. These issues were also brought up in the interview. What is interesting, is that the questionnaire and SUS, does not necessarily indicate that there are any issues. For instance, during the assessment of the usability on nutrition claims, a significant issue emerged in relation to the explanation and color coding. According to most of participants, the nutrition claims should be easier to comprehend. Specifically, in iteration four they suggested that the outcome of a claim should be presented alongside the claim itself, for example, "Low on

Sugar, fulfills the claim" rather than being placed at the end of the paragraph. In addition, the participant expressed confusion regarding the color coding, as the orange color was too similar to the red. This caused them to question the usability of both claims. Consequently, the function became unclear, and combined with the confusing text, the participants opinion of the function dropped. In order to make things more understandable, the color coding should only be green and red, this makes it easier to spot the claims that can be used. When asked "How well did you like the explanation in nutrition claims", the median of every participant was 4/5. In the SUS, the overall usability scored 85.5. This gives two completely different impressions of the feedback.

The calculator was further analyzed by categorizing issues with Nielsen's heuristics. It showed that many violations have been discovered, as also seen in (Bozkurt 2011; Nurhudatiana & Seo 2020; and Du & Bong 2022). The first violation can be seen in "visibility of system status". In correlation with Du & Bong (2022); and Bozkurt (2011), the length of text and information became an issue for some of the participants. In the food category the amount of text was to overwhelming. It was even mentioned by P5 that she would not take the time and read through each category. This is however difficult to find a solution for. The categories are gathered directly from the regulations, and to avoid selecting a wrong category the text needs to be this detailed, and long.

 As discovered in Bozkurt et al (2011) two violations occurred on "match between system and real world". The violations were related to redundancy of theoretical knowledge, and lack of remarkable and memorable information. In this study one violation were discovered for this heuristic. This instance was related to the order the nutrients were listed. The list did not match the regulation and confused the participants in the first iteration. The order was fixed for the second iteration. In the evaluation from Nurhudatiana & Seo (2020), they found that no violations were breached for this heuristic. This was however the only heuristic in their study that was not violated.

The heuristic "Consistency and standards" was violated on four instances for the calculator. Borzkurt et al. (2011), identified one issue related to badly designed and located game instructions. In this case the violation for the calculator was mismatching of words. In most of the cases there was used two different words to

describe the same thing. For instance, "innfrir" and "oppfyller" are two words with the same meaning. Only one of the words should be used, to make the calculator more consistent and precise. One other example was in iteration one, when "carbohydrates" was too high, the error message pointed to "added sugars".

In the first iteration, a violation for "user control and freedom" was identified. P2, struggled to add a new product. She managed to exit the page, by following a "back" button, that sent her to a different page. She needed help getting back to the calculator. To solve this issue, a button was placed on the bottom that refreshes the page, and a new product can be added. This was similar to an issue found in Bozkurt et al. (2011), where some participants struggled with navigation, and difficulty to return to the main page.

For the heuristic "Error prevention", the issue is that the button "share product" is somewhat unclear. Some participants did not know this button is meant for converting to PDF. An additional point is also for the "save product" button. If the goal is to save a product and add it to a list/database, the users need to know this before the action is completed. This can be done by adding a popup message. As for previous studies, issues related to "Error prevention" is more technical with error messages showing programming languages (e.g., 404 Error). This however has not been found on the calculator.

The last heuristic that was breached was "Help users recognize, diagnose, and recover from errors". For Nurhudatiana & Seo (2020), their issue was cosmetic, and for Bozkurt et al. (2011) the issue referred to lack of information. This is also the case here, and it refers to the lack of warning. The users should be warned that some nutrition claims can be misleading and cannot be trusted completely.

Despite there being violations of the heuristics, and some usability problems, there were no participant that experienced any big challenges using the calculator. This can be seen from the question "what do you think of the usability of the calculator", where the median score was 4,2. In addition, with the SUS scoring 85.5. This shows that despite the issues, the participants find the usability of the calculator to be almost perfect. A SUS score of 85.5, can according to Bangor et al. (2009) use the adjective "Best Imaginable" to describe the usability on a web page.

Since the first prototype, there has not been done any major changes on the design of the website. The only thing is three buttons have been added at the bottom. Based on the feedback every participant liked the design. They thought it was nice looking and simplistic, and easy to understand. This can also be backed up by the question "what do you think about the design", where the median score was 4,4.

In addition to the design, the nutrition claim function was also evaluated. The feedback that was received for this function can be divided into two groups, usability, and functionality. Most of the feedback was focused on the regulations, and whether or not a claim can be used. For some, this impacted their overall opinion on the function, as they were afraid mistakes could be done. When looking at the score for the question "what do you think of the nutrition claim function?", it received the median rating 4. Although this score is still considered good, the feedback received from the interviews revealed that the majority of the complaints were related to the nutrition claim function. The most common issues that was pointed out by the participants included poor color coding, mismatched words, unclear paragraphs, and the use of false claims.

5.2 Login and Welcoming Page

The other objective was to design and evaluate a member log in page, and a welcoming page. The design proposals were developed based on the feedback received from each iteration, in addition to recommendations and tips gathered from the literature review.

The first two design proposals for the login were created to get an idea of which direction to go. When choosing how the login should function, Bardram (2005); and Tran (2019), proposed the idea to not use usernames as an option, if not needed. For this reason, email was used as the identifier. This approach was also backed up by P1 and P2 as this was an annoying feature, and easy to forget all the usernames. When coming up with the design, two directions were explored. Either a simplistic design with little styling, or an elaborate design, with more colors, and the use of a full screen background picture. P1 and P2 were more impressed by the simplistic style, which resulted in focusing on that direction.

In the second iteration on proposal 2, the login form was place on the left side. The reason was because according to Yuan et al. (2014), the upper left side on the screen is where the eye first locks on to a target. According to P3, the proposal did not feel natural, as it was off centered, and the empty space on the right was too big. Even though the eyes might see the form quicker, the placement and design appeared to be more important for P3.

In the third iteration a picture was added to fill in the empty space on proposal 2. This was based on the feedback that proposal 2 was to boring. P3 who also tested the design in iteration two, thought the proposal got better with the picture. However, she thought the picture was to disturbing. P4 wanted a more relevant picture that is more descriptive for the calculator. Findings from Nielsen & Pernice (2009 p. 200); and Nielsen (2010), supports the comment from P4. A picture should not be added to a page simply to fill in white space. In addition, users pay close attention to photos that contain relevant information but ignore pictures that is used to "jazz up" the web page.

In iterating four, proposal 1 got a picture added in the background behind the login form. This was suggested by P3, P4 and P5.

The design proposal that was rated the highest, was proposal 1. When asked which design proposal they liked the most, proposal 1 was chosen 6/8 times, through every iteration. The main reason why proposal 1 was the most popular, was because it was centered. Most of the participants thought that it was more natural, and easy on the eye. According to the American scientist Alan Lightman, the human brains strive to see things symmetrically (BBC, 2017).

"The reason must be partly psychological," he says. "Symmetry represents order, and we crave order in this strange universe we find ourselves in... [It] helps us make sense of the world around us" (BBC, 2017).

Only two times did the second proposal get voted for, and it was P2 and P4 that liked the second proposal the best. Based on the results from the feedback, the design that will be proposed to Fremtidsmat as their main login page is, the final version of proposal 1.

The addition of the background picture on proposal 1 was well received by both participants in the final iteration (round 3). The whole page is centered and uses a consistent blue color throughout the page. It only shows necessary text. The page follows many of the suggestions given in Tran (2019); Bardram (2005); and Yuan et al (2014) and follows a simplistic design that is easy to understand, and easy on the eye.

The welcoming page was added as an additional task after the first iteration. The idea was to create a page that was similar to the home page of Fremtidsmat. A section was added above the picture slideshow. The task to design a welcoming page was a late addition to the study. Therefore, due to a limited timeframe only one proposal was prioritized and were shown to the participants. The feedback that was received for the welcoming page was limited. In iteration two, P3 had comments about the color of the button and adding a second paragraph. Besides this, the feedback was mostly positive. From the second iteration to the last, the main comments were usually, easy to understand, simple, and straight to the point. These comments might indicate that the page is well designed, with little to no usability issues. However, by only showing one design proposal at the time, the participants could not give the same amount of feedback as the login. Therefore, limiting potential feedback that can be used to make the page better. It is easier to spot weaknesses and strengths, and give pointers when comparing two designs against each other, rather than evaluating one design. For that reason, the welcoming page could have been looking much different, had the participants been given two designs to choose from, instead of one.

Nevertheless, the current welcoming page is simple and easy to understand and includes the most important aspect which is a direct link to the calculator.

5.3 Reflection of methods

The methods used in this study was inspired by Bozkurt et al (2011), and their approach for evaluating the usability of a personal nutrition tool. They argued using a multiple complementary method, comprised of "think out loud" method, a

questionnaire, and interviews, was one of the best ways to identify usability problems. This study supports that approach, as the results showed numerous benefits of using a slight variation of these methods (the think out loud method was replaced by testing tasks). By using this approach, it helped assess a variety of questions, from usability issues to identify specific interface problems. The testing tasks were able to give the participants a direct experience of the calculator, and collected information about factors that effected the ease of use, and the usability. The questionnaire gathered data about user satisfaction, usability, and the usefulness of the calculator. The interviews gave a more detailed understanding of their experience, and thoughts. The SUS questionnaire was also implemented, which could measure the usability on a higher scale.

When using a multi-method approach such as Bozkurt et al. (2011) did. It shows that both the questionnaire and the SUS score gives an indication of the usability and user satisfaction of the calculator. However, it fails to determine how and when specific usability issues occur in detail. This is where the testing tasks and interviews have their strengths.

With the multi-method approach, many problems were identified. An example of a situation where the same issue was confirmed by different methods can be seen in iteration three. Here, P3 expressed in the testing tasks that the nutrition claim she received, was not permissible to use. This was later confirmed in the questionnaire, where she was asked what she thinks of the nutrition claim function. She answered 3/5 and added that it would be higher if the claim could actually be used. The same issue was also brought up in the interview. Three methods were able to identify the same problem, and according to Thyvalikakath et al. (2009), problems that are identified by more than one method might be more severe than those identified by a single method.

Nevertheless, usability issues that was only identified by a single method, is still highly relevant, and do show the importance of using a multi-method approach. An example of this can be seen in iteration four, with P4. When she completed the testing tasks, her only comment was related to the reliability of the nutrition claims. In the questionnaire P4 answered 5/5 on every question, implying that there is no issue with the calculator. However, in the interview usability issues were identified. P4, did not notice the use of color coding before she was asked about it in the interview.

When she saw the color change from red to orange, she had no idea as to why it did not turn green. In addition, the two colors were too similar, and she thought that a user would have difficulties distinguishing the colors. P4 did also identify an issue regarding wordings. "Added sugars" was used to refer to "Carbohydrates" in nutrition claims and caused confusion. This backs up Bozkurt et al. (2011) claim that the ratings from a questionnaire, does not necessarily give the same impression as the feedback received in the interviews.

5.4 Limitations

This study has some potential limitations. The first is related to the sampling size. There was in total five participants, where three were tested on two occasions. The sample size was small due to different factors. One of the reasons was the lack of potential users that would be suitable for this evaluation. Since this is a nutrition calculator, the desired participants would be someone with knowledge of the field. In addition, Fremtidsmat provided a list of potential participants from their member companies, to be used as subjects. Due, to time constraints and difficulties scheduling meetings only four companies were able to take part in the usability testing. Since every participant is a member of Fremtidsmat a sampling bias might have occurred. According to Bhandari (2020), sampling bias occurs when members of a population are systematically more likely to be selected in a sample than others. By only using members from Fremtidsmat it might have limited the generalizability of the findings (Bhandari, 2020). What could have been done differently was to include nutrition experts outside of Fremtidsmat.

A second limitation regarding the sample size, is the number of participants. According to Nielsen (2000), the best results from a usability testing comes from no more than five participants. It shows that five participants is enough to find 85% of the usability problems on an interface. The issue is that Nielsen (2000) is refereeing to five participants per iteration. To uncover every usability issue, the recommended number of participants is 15, divided equally on each iteration. This means that to get the best results there should have been four participants for each prototype. For that reason, some usability issues might have gone unnoticed.

Another potential limitation is that three out of the five participants were tested twice. This might have impacted the reliability of the results. There is a risk that these participants may have been more familiar with the test procedures during the second usability testing, which could have impacted their performance and thus, the validity of the results.

The fourth possible limitation is related to the validity of the results gathered in the questionnaire. It became clear that some of the participants rated some of questions higher based on the potential, rather than the current state of the calculator. For instance, P4 answered 5/5 on every question in the questionnaire, and at the end she added "*I am pretty generous today, because I really want this calculator to be something that we can use in the future".* This might indicate an extreme response bias. According to Nikolopoulou (2022), extreme responding happens when the participant only choose the highest response available regardless of their actual opinion. The reason why she gave the highest ratings possible might be to ensure that future development would continue after this study. Other cases can also be made where the participants gave a higher score then they should, and this might show a false, or an unreliable median score.

There are also some potential limitations related to the login forms. It should be noted that the proposals that were shown to the participants, had low fidelity, and lacked interactive functionality. The participants did have prior experience using login pages, and therefore had some expectations about what a good login page should look like. However, the absence of functionality in the proposed designs could have limited their ability to provide more detailed feedback. Additionally, the calculator and the login pages were tested separately, and not as one whole application. This might have further impacted the participants ability to evaluate the login and welcoming page, since they cannot see the whole picture.

In addition, one thing that could have been done differently was to get an UX expert to evaluate the pages as well. According to Harley (2018), combining usability testing and expert reviews, will result in the best overall design.

The final limitation was only showing the participants one proposal for the welcoming page. Since there was nothing to compare with, it might have been difficult for the participants to see different solutions and give more detailed feedback.

6. Conclusion

In this paper, usability testing was conducted with five participants in four iterations of Fremtidsmat's nutrition calculator. Usability issues have been found in each iteration, and the calculator does have pros and cons in terms of usability. Feedback from the participants have been used to improve, and further develop the prototypes. The testing tasks were designed to evaluate usability and were based on Nielsen's heuristics. The questionnaire and SUS, in combination with the interviews was used to further evaluate the usability of the calculator. Through this study the findings show that this calculator has high usability and is easy to understand. According to the SUS questionnaire the calculator received the score 85.5. Giving it the highest usability rating, "Best Imaginable". Furthermore, in the questionnaire the median rating for the usability was 4.2. Despite the high rating there was however several violations for Nielsen's heuristics, and usability issues identified in the interviews. Such as confusing color coding, mismatch in the wordings, and unclear nutrition claims. Regardless of the issues, this calculator has great potential for the future, and holds a great value for every company or manufacturer within the Scandinavian food industry.

For future work, the first suggestion would be to improve upon the feedback gathered in iteration four, as this is yet to be implemented. For the second recommendation, since this study was focused on the usability of the calculator, the issues regarding the nutrition claims and if they can be used, needs to be further investigated. Future development is needed to strengthen the trust for the nutrition claims, and the goal should be to only show the claims that can legally be used according to the regulations. More nutrition claims should be implemented, and include claims for vitamins, iodine, calcium, etc. To help achieve this, collaboration with nutrition experts is highly recommended, and should be prioritized.

Currently this calculator is still under development, and the future course of action is to implement the function for health claims. The final recommendation for the calculator would be to pay attention to the labeling scheme "Nutri-score". P2 said this labeling scheme is something that is discussed and might come to Norway in the future. If this is the case, creating a function for "Nutri-score" should be considered.

The login page has seen great improvement throughout the iterations. The design was changed based on the feedback from the participants, and a final proposal was made. Future evaluations could include experts outside of Fremtidsmat, and an UX designer, to gather more feedback. The welcoming page have also seen some changes, however further improvements to the design can be made, and should be considered. For future work, a high-fidelity login and welcoming page should be implemented with the calculator. By integrating all the features and testing them as one coherent website, future usability testing would provide a more comprehensive evaluation.

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