
An Application Promoting Lifestyle Changes for Young Adults with MS



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Abstract

This master thesis presents a Design Science research study of an application promoting a healthy lifestyle where the aim is to increase life quality for people with Multiple Sclerosis (MS). A User-Centered Design method was also integrated into the project to ensure that user requirements and approvals regarding content and design were achieved.

The application is designed for young adults in Norway, who are newly diagnosed or people who seek information about how to increase life quality while living with the chronic disease MS. Nobody is a patient 24/7 and there is no need to be reminded of the disease if not necessary. With a self-management application, people with MS can take control of the condition when they are in asymptomatic periods, and hopefully, only feel the need to contact medical staff when absolutely needed.

A high-fidelity prototype has been implemented where the main functionalities are health, training, patient notes for the next medical appointment, disease-related life and work issues, and a reward point system.

The development processes consisted of five design iterations where design principles, usability testing, a system usability scale, and Nilsen's heuristics were used to deliver satisfactory solutions. The resulting application YmsE strived to achieve the best balance between medical information and lifestyle information.

Abbreviations

HCI- Human Computer Interaction

MRI- Magnetic Resonance Imaging

MS- Multiple Sclerosis

NSD- Norwegian Centre for Research Data

PPMS- Primary Progressive Multiple Sclerosis

RQ- Research Question

RRMS- Relapsing-Remitting Multiple Sclerosis

SPMS- Secondary Progressive Multiple Sclerosis

SUS- System Usability Scale

UCD- User-Centered Design

UI- User Interface

VER- Visual Evoked Response

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Chapter 1

Introduction

Multiple Sclerosis (MS) is a chronic disease that attacks the central nervous system. It can occur at any age and most affected people will get the diagnose between the age of 20 to 50 [1]. However, it is known as “young people disease”. Chronic disease does not mean the person affected has to live at the hospital 24/7, so for this research, it has been important to not refer to them as patients.

There is no specific test for MS, so the diagnosis can be missed [1] or can take a long time to get. The symptoms vary widely, thus it can be hard to see the correlation between the symptoms and the disease. The diagnostic phase can be difficult and challenging for people. It hits hard especially for young adults who are forced to accept their new condition of life and understand the consequence of the disease. Limited available information does not make the initial phase easy either.

It is common to receive lots of disease-related information in a short amount of time, during consultations and hospital visits. The rest of the time the young adults have expressed the feeling of almost being neglected. The reason for this might be that the MS is not active, and they do not require daily medical help. Regardless of that, periods of remissions are important to take care of mental and physical health, for which mobile technology could be of great help. Many young adults in Norway are very familiar with using their smartphones in everyday tasks. Instead of giving them pamphlets with medical information, why not consider using an application to deliver information, knowledge, and support.

This research wants to design solutions for a healthy lifestyle and increased quality of life, by developing a high-fidelity prototype. It is important to mobilize and motivate people to achieve what they want in life, instead of reminding them of symptoms and problems.

Design Science is a scientific approach that provides methods in which relevant solutions are designed for real people and real environments aiming at contributing to the already existing knowledge. Working closely with the potential user group, young adults with MS have been interviewed, presented with design choices and asked about preferences and information needs. The main goal and focus of this research were to develop an IT solution for young adults in Norway, who are newly diagnosed.

1.1 Research Questions

The following are Research Questions (RQ) that will be answered during this research project:

RQ1: *What functionalities needs to be included in an application for young users with MS in Norway, that would help improve lifestyle changes and gain approval from both users and medical staff?*

RQ2: *What is a good proportion of medical information and lifestyle information in an application for people with MS?*

1.2 Outline of Research Project

The following is an outline of the research project:

Chapter 2: Medical Theory displays what MS is, who might get it, the diagnosis, different types of MS and symptoms.

Chapter 3: Literature Review summarizes the literature and related work during this project.

Chapter 4: Methodologies and Methods explains the methodologies and methods used in this project and their contributions.

Chapter 5: Requirements displays ethical considerations, the target group, and participants of this project and the requirements gathered from and by users.

Chapter 6: Prototype Development displays the different tools used and the five design iterations achieved.

Chapter 7: Features for YmsE displays the final functionalities of the high-fidelity prototype.

Chapter 8: Evaluation summarizes the results from evaluations during iterations.

Chapter 9: Discussion goes through the methodologies, methods, and development process used. It answers the research questions.

Chapter 10: Conclusion and Future Work concludes the project with a summary and recommendations about future work.

Chapter 2

Medical Theory

Multiple Sclerosis, also known as MS, is a chronic disease that attacks the central nervous system. For persons with MS, their own immune system start to attack tissues in the brain and spinal cord [2]. Some may experience long periods without symptoms (asymptomatic periods), whilst other with severe MS could eventually lose the ability to walk or see. A relapse is a period when attack(s) suddenly sets the disease on and the person may suffer symptoms again. Remissions, on the other hand, is a time with no symptoms and even signs of improvements or of wellbeing as compared to acute periods. The purpose of treatment is to slow down attacks and enable a remission phase, during which an active and healthy lifestyle should help maintain life quality.

2.1 Who Might Get MS?

MS can occur at any age, but most common is from the ages of 20 to 50. Research has shown that women are twice as likely as men to develop MS [3]. Some also believe that the chance of developing MS is higher in temperate climates, with mild summers and cold winters. Factors such as family history and race could also be relevant. If one person in a family has MS and is of Northern European descent, the risk is higher [2]. It is not proven that MS is genetic, but since family members are usually exposed to the same factors, it could be plausible that more than one member of the same family could develop MS.

2.2 Establishing Diagnosis

It is important to get the diagnosis, so treatment can start as early as possible. The neurologist needs to dismiss other causes before setting the final diagnosis. For some, this might be a quick process, but for others, it might take a long time and suffering due to unknown causes. Some of the methods used to establish the diagnosis are as followed. A *neurological examination* which is a physical examination where movement, coordination, sensory properties, and visual ability are some of the things being checked. A *Magnetic Resonance Imaging (MRI)* that takes pictures of the brain and spine to look for scarring. A *lumbar puncture* where a sample of the spinal fluid from the lower back is collected and analyzed for biomedical markers. There is also a *visual evoked response (VER)* to check if there is a delay when taking a visual stimulation test [4].

2.3 Types of MS

2.3.1. Relapsing-Remitting Multiple Sclerosis

Relapsing-Remitting Multiple Sclerosis (RRMS) is the most common form of the disease, identified in around 85% of those with MS. Attacks are triggering different symptoms that could last anywhere from a few days to several months. It is then normal for the attacks to completely or partly disappear after the active phase. Research has shown that it is normal to have an average of 0.8 attacks each year, where every attack may lead to a worsening of the disease. It is believed that those with RRMS might move on to the secondary progressive type [2][5].

2.3.2 Primary Progressive Multiple Sclerosis

Primary Progressive Multiple Sclerosis (PPMS) is a type in which 10-20% persons will have a slow start with little symptoms, but the disease will gradually get worse over time. There are not necessarily signs of attacks and the loss of functional ability could span over many years. PPMS stands out compared to the other types, considering people diagnosed with PPMS are usually older with an average age of 40. Another difference is that there is an equal amount of men and women living with it [2][5].

2.3.3 Secondary Progressive Multiple Sclerosis

Secondary Progressive Multiple Sclerosis (SPMS) is a type that 65% of those with untreated RRMS develop. It usually occurs 10-20 years after being diagnosed with RRMS. SPMS is hard to treat and can be difficult to handle on a day to day basis. In the early phases, the disease is affected by inflammations, which can be treated by medicine [2][5].

2.4 Symptoms

Symptoms are also known as attacks which a person with MS might experience in the form of impaired vision, fatigue, difficulty balancing, mood swings, weakness in limbs, slurred speech and dizziness, just to mention the few most characteristic [2].

Asymptomatic periods can be long, but that does not mean that the disease might not relapse. It is during this period that persons living with MS are advised to maintain a healthy lifestyle that will keep remission periods lasting. The application developed in this research strives to help during this period.

Chapter 3

Literature Review

This chapter presents a literature review of relevant research for this project. The review gives an overview of physical activity, nutrition, and supplements, young adults, newly diagnosed, technology, mHealth and methods used for creating an application focusing on accessibility, usability, and user experience. Lastly, there is an overview of related work.

3.1 Relevant Literature

3.1.1 Physical Activity for People with MS

The entire population would most likely get benefits from working out. MS is a disease which affects a person's fatigue and could make it problematic to have enough energy to perform tasks that a healthy person would have no problem with. When gathering data about the subject, even considering what kind of disability level the MS has evolved to, recent research has proven that physical activity will help improve the life quality for a person with MS [6]. Information about physical activity for a person with MS has changed over the years. They were previously told to save their energy for everyday tasks, but it is now proven that exercise is well tolerated and even provide positive effects for a person with MS [6].

Outside factors such as age, education, and employment can be variables that affect the ability to perform physical activity to the recommended degree [7]. Thomas S. et al conducted a trial to see if Nintendo Wii could offer a fun and convenient way to get benefits from physical activity. They tried exercising with a home-based "physiotherapist" by using the Nintendo Wii. The results were positive and indicated that researchers were encouraged to explore more such options for a workout [8].

80% of those with MS do not meet the recommended amount of training, meaning there is a lot of room for improvement [9]. There is a focus on a paradigm shift, where the amount of inactivity by adults, has been shifted from "exercise training for fitness" toward "physical activity for health" because people want to see the benefits from a healthier lifestyle and not only about physical appearance [9].

Robert W. Motl looked at results gathered from a span of six months where a change in walking impairment had improved for 269 persons with MS [9]. One survey stated that 93% of the persons with MS used the Internet compared with 75% of the general population. In addition, there was another survey where more than 80% of the persons with MS expressed a high level of interest in having online access to general information about MS, and nearly 90% were interested in online information about maintaining a healthy lifestyle [9].

3.1.2 Nutrition and Supplements

Supplements are often mentioned in articles about MS and a healthy lifestyle, unlike nutrition, which is often neglected. Food and vitamins seem to be an easy step a person can take on their own initiative to help improving health, but there are not enough studies about the topic. The result of prior studies is not providing evidence to significantly confirm healthy benefits for persons with MS [10][11].

There is not enough evidence proving that steps like cutting out gluten or dairy will have an effect. However, it would still be beneficial for a person with MS to have an appropriate diet to help them maintain their nutritional status and health [12]. It is therefore suggested to talk to a doctor and nutritionist to discuss food habits, diets, and nutrition from when they are newly diagnosed and that it would be important to have follow-ups.

3.1.3 Young Adults Living with Chronic Illness

There are not many articles with data about young adults with MS, which is strange considering the disease usually affects those between 20-30 as well. Data collected is mostly by people with MS, who have a more severe form of MS at the age of 40 or more.

Chronic pain or illness often carry extra burdens, especially when their disability is invisible [13]. The ignorance surrounding young adults with an illness that is not necessarily visible is a problem. Toni Bernhard J.D. mentions that young adults with a chronic illness often feel left out since they may not be able to participate in the same activities as their peers and they usually blame themselves for it. She recommends finding activities they enjoy, where they can find others in real life or online with the same interest and understanding that it is not their fault [13].

3.1.4 Newly Diagnosed

To receive the diagnose MS is a life-changing period in a person's life as they start to realize that the illness will affect them and the people around them for the rest of their life. It is shocking to realize that the condition could affect their quality of life and it is therefore important to early on have a focus on those who are not in the worst shape. Newly diagnosed need relevant information and knowledge about the disease to help them adjust to the new situation. It is usual to receive medical information from a neurologist (e.g. the diagnosis, treatment options, what an attack is, whom to contact and risk factors) [14], but somewhat less non-disease related information. The emotional burden and quality of life of recently diagnosed people with MS and their family/partners demonstrate high levels of anxiety and distress in the early period after the diagnosis [15]. The quality of life is suddenly not optimal, and changes are significant, so help and information to newly diagnosed should be re-evaluated [15][16].

3.1.5 Trust of Technology and mHealth

Technology is always evolving and improving. It is easy to publish information on the Internet, so how should a person with MS trust the quality of the information? To use the Internet as a source for health information is common, but since there are few regulations for websites, it could lead to incorrect and misleading information. The research and tools that are being used to evaluate websites for quality on health websites are not as many as it would be appreciated [17]. The lack of medical credibility makes many applications not trusted either by users or medical staff. In order to include correct and relevant information, it is important to establish a close collaboration with medical staff and other experts.

The majority of people with MS use modern communication technology on a daily basis. They receive information through searching on the Internet, online communities, applications and emails with physicians, proving high acceptance rates in forms of new technology to help inform about MS [18].

Applications are not only in the form of games and entertainment, but also applications used to help remind a person to walk a certain amount, track their food, write reminders and perhaps monitoring a disease. There is a severe amount of applications dealing with health and fitness issues on the market today. The acceptance of applications relating to a healthier lifestyle is increasing [19]. Haase at al. explained an increasing trend of using electronic aids to gather health information online. They state that young women represent the highest percentage of users, and considering that MS usually affects young females, the article believes that those with MS are perfect candidates for testing electronic communication aids [20].

A systematic review from 2016 in the USA, researched how many applications in the Google Play store and iTunes store were directed towards people with MS. The results have shown there were only 25 applications. They stated that most of the applications were about the disease and treatments for MS. The second important category was regarding disease management [21]. If the gap between applications for MS and other mHealth applications is so big in the USA, it is easy to assume that there are even fewer applications in Norway.

mHealth services and applications have already a very important role in the restructuring of the old healthcare services and systems. They are based on the relationship between patient and physician. Moreover, mHealth applications have a strong impact on all healthcare services, such as hospitals, care centers, and emergency attendance [22].

When creating a lifestyle application for young adults, technologies promoting wellbeing, connecting people and guiding them towards the best available help should be used [23]. Another important issue is to assess the effectiveness of the intervention with measurable means [24].

3.1.6 User Experience and Usability

Research shows that participants desire interactive features and motivated engagement, as well as responsive design. Functions need to work similarly across devices, with the aesthetic and functionality preferences from intended users [25]. Instead of the traditional text-only, users have expressed they prefer infographic summaries [26]. The results from a study regarding visualization of health information and mHealth claimed that infographic poster formats are more aesthetically appealing but demonstrate similar clarity and comprehensibility as a traditional poster format [27].

Mobile software applications must cope with a particular environment that involves small size, limited resources, high autonomy requirements, competitive business models and many other challenges [28]. Current mobile software quality practices have evolved by adapting practices from Agile and plan-based methodologies, incorporating product measurement, best practices, testing techniques, design patterns, and other similar considerations. Mobile devices are currently the most important platform for the introduction and utilization of software products and services [28].

Mobile Software Engineering still faces an extensive workload to determine what are the best processes and practices that facilitate the creation of high quality, successful mobile software products [28]. Evaluations should be conducted by experts and users, by performing Nilsen's Heuristics [29]. To reach good accessibility, usability, and user experience, there are plenty of evaluation methods and guidelines, to the point that there could be even too many [29].

Due to the widespread of mobile devices, consumers expect user-friendly and well-designed mobile applications from service providers in various industries. So far, little systematic help has been offered to evaluate existing mobile applications. The conceptualization and instrument of mobile application usability is an important contribution for information systems and human-computer interaction research because it helps theory development in various research areas, such as mobile technology adoption research, mobile user interface evaluation, and mobile application development [30].

3.2 Related Work

3.2.1 Available MS Applications

When searching for MS in the Google Play store, the applications were mainly from the USA and Germany, therefore more catered towards their medical systems (Figure 1). The only available Norwegian application concerning MS is SymTrac, which is originally created for the American market, but translated into Norwegian. There is no published evaluation or evidence from using SymTrac in the Norwegian health care systems.

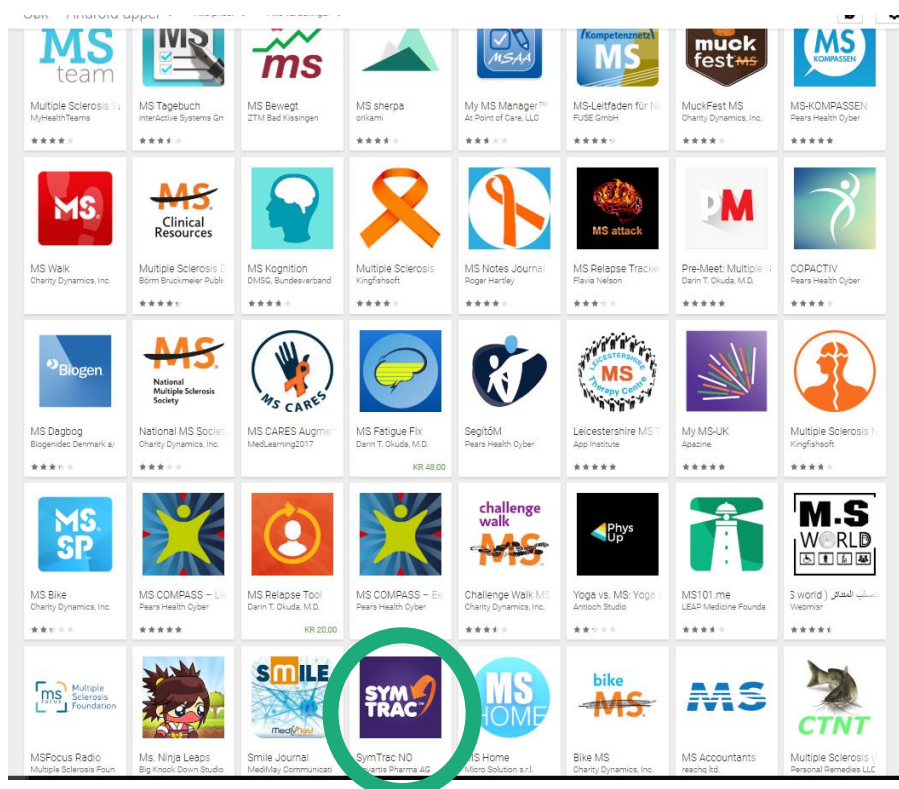


FIGURE 1: MS APPLICATIONS FROM GOOGLE PLAY STORE

3.2.2 msHelse

The Norwegian high-fidelity prototype named msHelse consists of four modules: *diary module*, *summary module*, *stress management module*, and a *todo-list* (Figure 2) [31]. The prototype aims to be a tool for persons with MS to follow disease development and provide knowledge about the disease to the users.

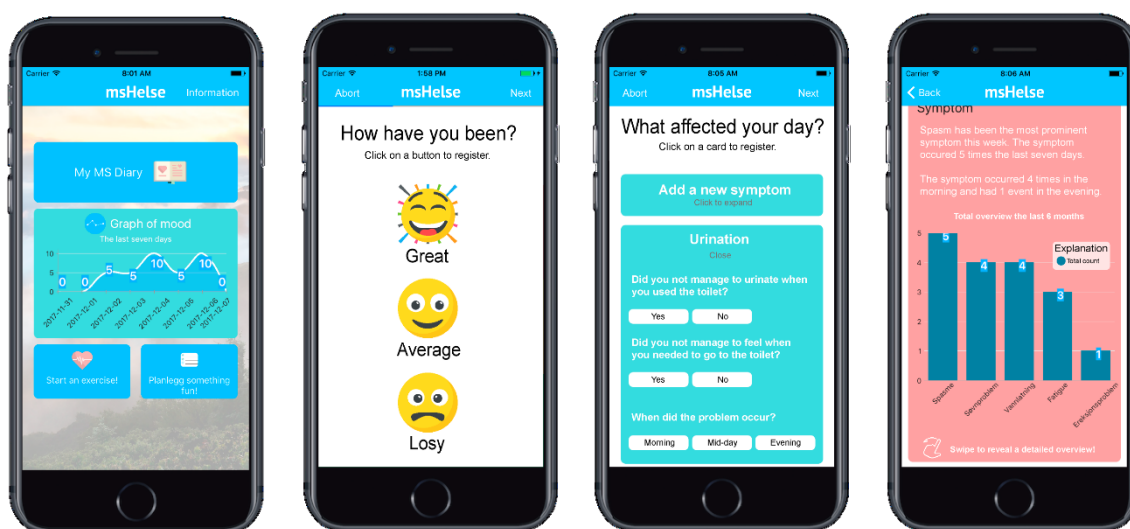


FIGURE 2: FOUR WIREFRAMES OF MSHELSE – SHOWING MAIN FUNCTIONALITIES

msHelse has been evaluated by users and thereafter refined to incorporate the needs of Norwegian users. Medical experts were interviewed to evaluate the design. Suggestions were given, as to how to encourage the user to plan desired activities and learn how to live with the disease [32].

Experts found exercise to be generally favorable but needs to be adjusted regarding symptoms. It could be problematic to exercise when suffering from fatigue since fatigue drains energy. Exercise could also be a learning process of understanding one's own limits. Furthermore, it was important to shift the focus from managing symptoms to preventing them [32].

Chapter 4

Methodologies and Methods

This chapter displays methodologies and methods used to conduct this research project, to gather data and analyze it.

4.1 Design Science

There are three different cycles to considerate when designing an artifact, according to design science research. Figure 3 shows the three different cycles, *relevance cycle*, *design cycle*, and *rigor cycle*.

The first cycle that is displayed, is the relevance cycle which is concerned with the environment surrounding the intended artifact. It is important to understand the potential user group(s), their particular needs and expectations from an artifact. The second cycle is the design cycle, which iterates between design options and their evaluation, with the goal to deliver an artifact. Rigor cycle is the third one, which utilizes prior knowledge relevant for the design of an artifact as well as scientific methods that are useful for the design development [33]. Methods of the rigor cycle secure the validity of the research.

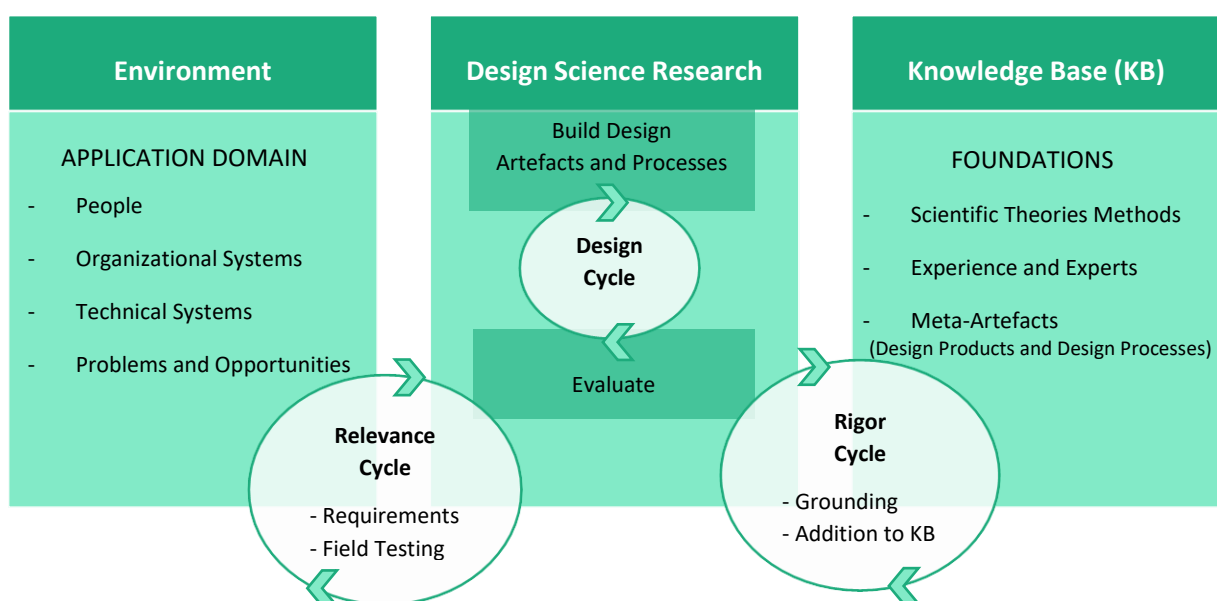


FIGURE 3: DESIGN SCIENCE RESEARCH CYCLES

Since 2004 there have been seven guidelines that are heavily integrated into top quality design science research [34]. The seven guidelines consist of:

1. Design as an artifact
2. Problem relevance
3. Design evaluation
4. Research contributions
5. Research rigor
6. Design as a search process
7. Communication of research

Hevner et al. have suggested a more specific checklist to ensure researchers that the key aspects of design science research are being covered [34]. The eight questions of the checklist can be seen in Table 1. Design science is a powerful method for including users, developers, and experts of different backgrounds. By documenting research steps, it is possible to secure a sound development with relevant results.

Questions	
1	What is the research question (design requirements)?
2	What is the artifact? How is the artifact represented?
3	What design processes (search heuristics) will be used to build the artifact?
4	How are the artifact and the design processes grounded by the knowledge base? What, if any, theories support the artifact design and the design process?
5	Which evaluations are performed during the internal design cycles? Which design improvements are identified during each design cycle?
6	How is the artifact introduced into the application environment and how is it field tested? What metrics are used to demonstrate artifact utility and improvement over previous artifacts?
7	What new knowledge is added to the knowledge base and in what form (e.g., peer-reviewed literature, meta-artifacts, new theory, new method)?
8	Has the research question been satisfactorily addressed?

TABLE 1: A CHECKLIST FOR RESEARCHERS - KEY ASPECTS OF DESIGN SCIENCE RESEARCH

4.2 User-Centered Design

User-Centered Design (UCD) is a design process where the focus is on the intended user and their needs throughout the design process [35]. Good design is more than just content. Users are expecting to be presented with a well-functioning and easy to use systems, so it is important to have a good User Interface (UI).

UCD has four phases to follow [35] in order to satisfy user needs. The phases are shown in Figure 4, and the process resembles the design science research cycles to some extent, but it is more focused on the design itself. The first step is to understand the *context of use*. The second phase is to *specify requirements*, both functional and non-functional. *Producing design solutions* is the third phase. The fourth stage, but not necessarily the last, is to *evaluate the design*. It is important to test and evaluate each design iteration to be sure that the outcome will be satisfactory for the intended user. If not, the process will be repeated until the users' needs are met.

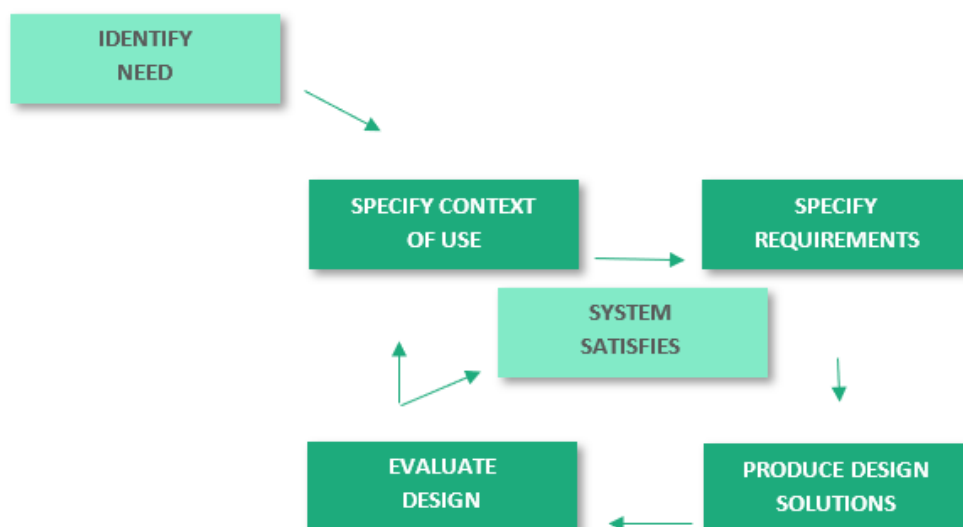


FIGURE 4: MODEL OF A USER-CENTERED DESIGN PROCESS

4.2.1 Conceptual Design

The conceptual design transforms established requirements for the application into a conceptual model [36]. A conceptual model shows the main functionalities and how users can interact with the application. It is an outline that illustrates what can be done with a product and what is needed to interact with it [36]. There is no wrong way to use conceptual design, but there are some key principles for guidance. The key principles can be found in Table 2. A conceptual model can be instrumental in the starting phase of development.

Keep an open mind, but never forget users and their context	Discuss ideas with other stakeholders
Use prototyping to get rapid feedback	Iterate iterate iterate.

TABLE 2: KEY PRINCIPLES OF CONCEPTUAL DESIGN

4.2.2 Prototyping

Prototyping is creating interactive products for the user to test and evaluate. It can be hard for users to explain exactly what they want, but easy to say what they do not want once they have a product to interact with [36]. A prototype can be anything from a hand-drawn prototype to a complex system since a prototype only is a temporary version of the product [36]. It is normal to divide between levels of fidelity, usually ranging from a low-fidelity to a high-fidelity prototype. For this research project, there will be used three different levels of fidelity when prototyping.

Low-fidelity prototyping is good for creating a layout and multiple design options but is bad at discovering usability issues. Following are three methods used during this project when creating low-fidelity prototypes:

Sketching is a cheap and time effective way of getting a lot of different design solutions, drawn by hand.

Wireframing is to represent the layout and content.

Mock-up is displaying how the design will look with references to colors, content and in-depth description.

Mid-fidelity prototype is a mixture of the correct content and functionalities but is still missing key elements, such as full functionality.

High-fidelity prototyping is close to the final product. The prototype is easy to evaluate and test on when trying to detect usability issues. A negative aspect is that this prototype requires a lot of energy and time.

4.3 Design Principles

Design principles are used by interaction designers when designing for user experience [36]. To focus on the user experience and create a good UI, there are five well-known principles that should be integrated ensuring certain features are provided to the interface [36].

Visibility is that a user should see all the different options they can click on. Nothing should be hidden for the user because the UI should be intuitive. However, if everything is visible, it will create clutter on the interface, so a balance is important [37].

Feedback is for the user to understand that the action they performed has been accomplished. The user should never guess what the consequence of their action was. Feedback can come in many forms, but in interaction design, it is normal to use feedback such as visual, tactile and audio [37].

Constraints make it harder for a user to make mistakes. It will limit the range of interaction options for the user since many options can make users confused about what the right option is [37].

Consistency is important when creating an artifact. There should not be any surprises in the design, meaning that similar operations and similar elements should be used for achieving similar tasks [36] [37].

Affordance is about using symbols people already are used to, so they understand what the action is, e.g. an envelope meaning mail, a house meaning home and so on. To afford means to give a clue, so an artifact with strong affordance is clear how to use it [37].

4.4 Data Gathering

In Figure 5, there is a model with different ways of collecting data from both users and experts by applying different methods. Qualitative data methods rely on interviews to collect opinions, personal experiences and often makes it easier to gather unexpected data due to the open discussion [36]. However, the downside is that this method might be time-consuming, and it might be hard to gather

many interview subjects to be representative of the wider user group. Quantitative data is a good way of gathering data about subjects from many people at the same time using, for example, surveys. They are also quick and easy to perform, but they often consist of closed-ended questions, which may leave out interesting and valuable information.

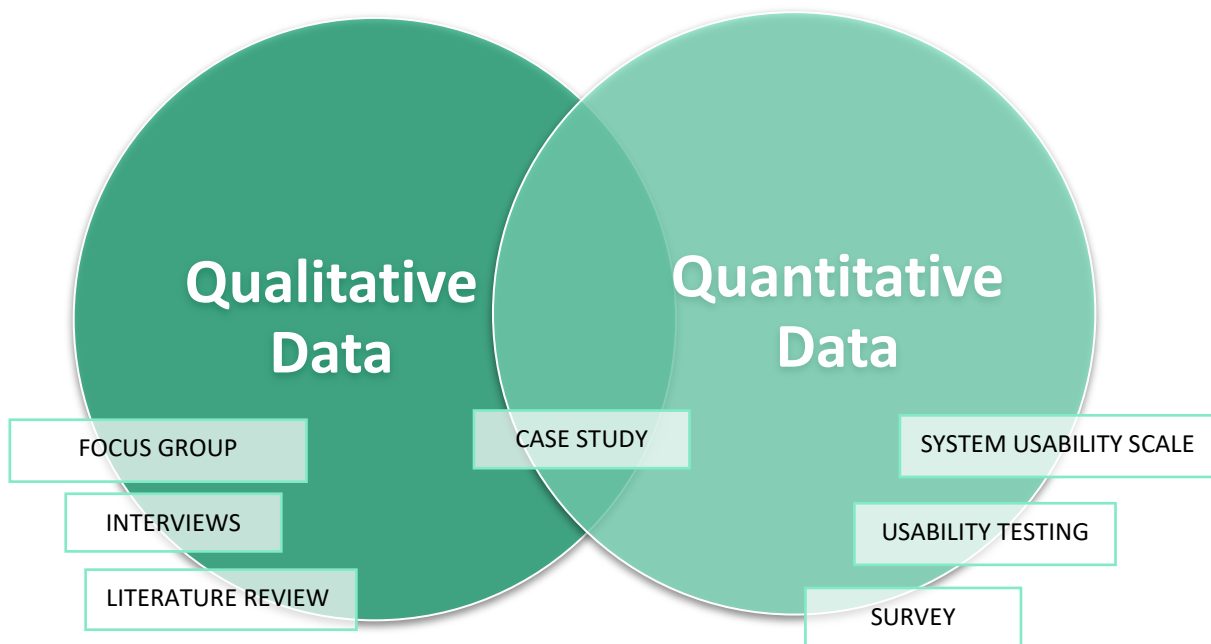


FIGURE 5: MODEL OF METHODS USED WHEN GATHERING DATA

4.4.1 Literature Review

A literature review is the gathering of and analyzing already published articles, books, reports and other relevant documents for a specific topic using a set of keywords. It provides a summary of all relevant information regarding data, methods, and approaches employed in the research. It can also contribute to establishing requirements for an artifact development.

4.4.2 Semi-Structured Interview

Semi-structured interviews are using a set of pre-defined questions that gives the structure of the interview. The questions are asked and open for discussion and answers. With semi-structured interviews, there is a basic guide to making sure that the same topics are covered with each interview

[34]. This method was used during the interviews with the medical staff at Haukeland. An interview guide approved by NSD can be found in Appendix A.

4.4.3 Focus Group

A focus group normally consists of three to ten people who share some interest in a project, activity or a product [36]. A focus group is good for collecting multiple viewpoints on different questions and issues. In this research, there was one online focus group, interested in managing and living with MS, increase life quality and help contribute to the design and content of an application.

4.4.4 Survey

A survey is a quantitative research method comprised of a questionnaire with the intention of an efficient gathering of data from a set of respondents. The number of participants can be very high. A survey mainly consists of closed-ended questions with very few open-ended questions for free form answers. A questionnaire is a well-established technique for collecting data and users' opinions [36].

4.4.5 Case Study

A case study is an intensive method to study an individual, a group or a community to get in-depth information about the topic being researched [38]. In this research, two individuals with MS were asked to explain how it was to live with MS and how they would interact with the application. The case study was conducted in a controlled setting with the intended user of the application.

4.5 Evaluation of Prototypes

Evaluating the prototype is a part of the development often included at the end of each design iteration. There are many ways of evaluating a product. It is common to include both experts and users, to make sure the content is relevant, and the design is satisfactory and intuitive. Usability is a property of design, related to learnability and easiness of use from a human-made object.

4.5.1 Usability Testing

Usability testing is evaluating the intended product by the intended user [36]. In this case, it was young adults from Norway, who are newly diagnosed with MS and who evaluated the application “YmsE”. Whilst the users test and try to accomplish different tasks, it is important to observe, take notes and sometimes measure the time for the different actions the users perform. The goal of the testing is to learn if the UI is intuitive and that the user can successfully complete the set of tasks, which makes it possible to identify changes resulting in improvement of user satisfaction.

4.5.2 System Usability Scale

System Usability Scale (SUS) is a quick method for testing the usability of a product. It was created by John Brooke in 1996 and still remains relevant in the industry [39]. SUS is a Likert scale that is used for measuring opinions [36] based on 10 questions. The user will mark one box out of five options, ranging from *strongly disagree* (1) to *strongly agree* (5). Figure 6 displays the two first questions of the SUS with the five boxes, whilst the entire form is shown in Appendix C.

	1	2	3	4	5
1. I think that I would like to use the app frequently					
2. I found the app unnecessarily complex					

FIGURE 6: COMMON QUESTIONS FROM SUS

When calculating the SUS score, there are many ways of measuring, it can be grades, adjectives, and percentage to mention some [40]. Figure 7 was created by using information from A. Bangor, P. Kortum and J. Miller [41]. Presented are the three measuring types taken into consideration when evaluating the application *grade*, *adjective*, and the *SUS score*.

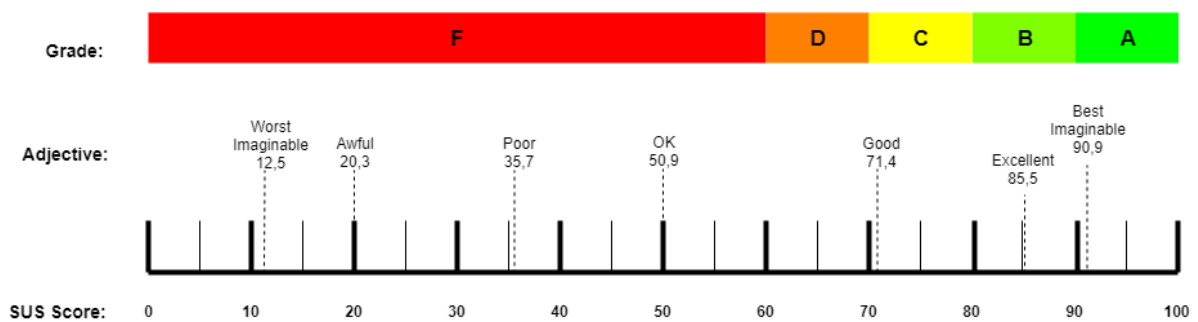


FIGURE 7: DIFFERENT VERSIONS TO MEASURE USABILITY WITH SUS

The ten questions are structured in a way that makes the odd numbers a positive load question and the even number a negative loaded question. When calculating the score, the odd numbers will be subtracting 1 from their value and the even numbers will subtract their value from the number 5. After adding the final score, the next step is to multiply with 2.5 to get the SUS score out of 100. It is important to remember that the result is not a percentage, but a SUS score. The empirical research has established that a SUS score above 68 is regarded as a standard good score [40].

If using Figure 6 as an example, and a user cross out number 4 in the first question and number 1 on the second question, the equation would be:

$$4 - 1 = 3 \text{ and } 5 - 1 = 4$$

$$3 + 4 = 7$$

$$7 \times 2,5 = 17,5$$

17,5 will be a part of the SUS score.

4.5.3 Nielsen's Heuristics

Nielsen's heuristics are 10 usability heuristics (Table 3) for creating a good UI. The method's goal is to find usability problems in the UI during design iterations. Heuristic evaluation involves a small set of evaluators to examine the UI with the usability principles [42]. The evaluation should be performed by usability experts individually, before discussing the result in plenum. Most of the principles overlap with the previous principles mentioned in Chapter 4, but they also bring new and more specialized versions for accessing usability. Figure 8 shows that a number between 3 to 5 evaluators could identify 75% of the problems found. Nielsen's heuristics were used in this research to evaluate the artifact by three usability experts.

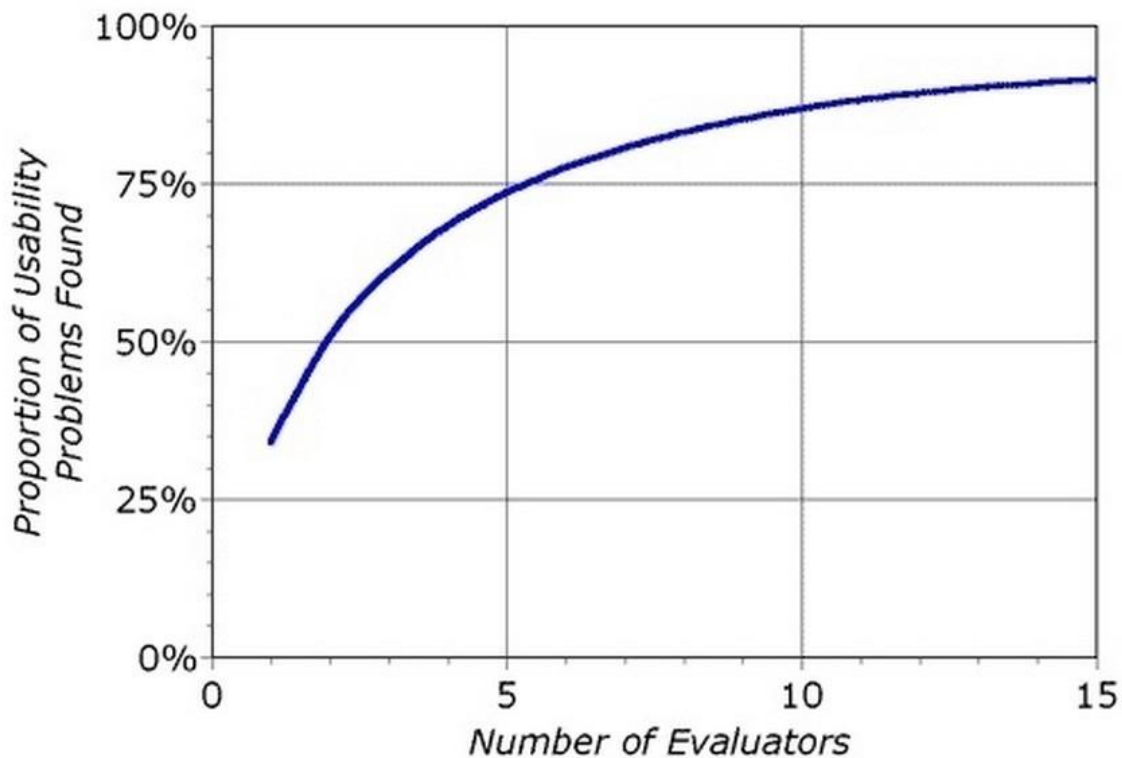


FIGURE 8: THE PROPORTION OF USABILITY PROBLEMS IN AN INTERFACE USING VARIOUS NUMBERS OF EVALUATORS [42]

Nielsen's Heuristics	
Visibility of system status	The system should always keep users informed about what is going on, through appropriate feedback within a reasonable time.
Match between system and the real world	The system should speak the users' language, with words, phrases, and concepts familiar to the user, rather than system-oriented terms. Follow real-world conventions, making information appear in a natural and logical order.
User control and freedom	Users often choose system functions by mistake and will need a clearly marked "emergency exit" to leave the unwanted state without having to go through an extended dialogue. Support undo and redo.
Consistency and standards	Users should not have to wonder whether different words, situations, or actions mean the same thing. Follow platform conventions.
Error prevention	Even better than good error messages are a careful design which prevents a problem from occurring in the first place. Either eliminate error-prone conditions or check for them and present users with a confirmation option before they commit to the action.
Recognition rather than recall	Minimize the user's memory load by making objects, actions, and options visible. The user should not have to remember information from one part of the dialogue to another. Instructions for use of the system should be visible or easily retrievable whenever appropriate.
Flexibility and efficiency of use	Accelerators — unseen by the novice user — may often speed up the interaction for the expert user such that the system can cater to both inexperienced and experienced users. Allow users to tailor frequent actions.
Aesthetic and minimalist design	Dialogues should not contain information which is irrelevant or rarely needed. Every extra unit of information in a dialogue competes with the relevant units of information and diminishes their relative visibility.
Help users recognize, diagnose, and recover from errors	Error messages should be expressed in plain language (no codes), precisely indicate the problem, and constructively suggest a solution.
Help and documentation	Even though it is better if the system can be used without documentation, it may be necessary to provide help and documentation. Any such information should be easy to search, focused on the user's task, list concrete steps to be carried out, and not be too large.

TABLE 3: NIELSEN'S 10 HEURISTICS TO FOLLOW FOR A GOOD USER INTERFACE

Chapter 5

Requirements

This chapter presents ethical considerations and appropriate approval that was obtained from the Norwegian Centre for Research Data. The target group, users who participated in testing, medical experts and usability experts is also presented. Lastly, there are requirements gathered mainly from an analysis of a social media platform.

5.1 Ethical Considerations

This research has been approved by the Norwegian Centre for Research Data (Norsk senter for forskningsdata - NSD). All the participants involved in the project have signed an inform consent prior to interviews, testing, and evaluations. The approval from NSD is in Appendix A. Inform consent and interview guides can be found in Appendix B.

All the research participants were informed of their rights to be removed from the research at any point in time and that their privacy would be secured. No sensitive questions regarding their private lives would be asked.

5.2 Target Group

The target group has been young adults between the age of 20 to 30, living with MS in Norway. This choice was made to focus on those who are newly diagnosed and not heavily affected by the disease. However, they had to make adjustments to maintain an active and healthy lifestyle. Both genders were required but considering that there are more women diagnosed with MS, it is a higher number of female representatives in this research. It was important for the research that the target group was interested in technology and willing to use applications (Table 4).

Gender	Male/Female
Age	20-30
Diagnosis Established	3-5 years
IT Criteria	A user of a smartphone, active on social media platforms

TABLE 4: TARGET GROUP REQUIREMENTS

5.3 Research Participants

5.3.1 Users

The users have been recruited through a Facebook group called *MS-Ung I Norge* and through personal connections. They served as a mini social media focus group which consisted of four females and two males. One case study was carried out in addition, with one male and female participant, who performed a SUS and usability testing.

5.3.2 Medical Experts

The medical experts consisted of an MS-neurologist, an MS-specialist nurse and three physiotherapists from Haukeland University Hospital in Bergen. They were recruited through university connections. They took part in semi-structured interviews.

5.3.3 Usability Experts

Three usability experts from the University of Bergen contributed to the research. One female and one male have a bachelor degree in Information and Communication Technology. The second male has a master degree in Information Science. They evaluated the application using Nielsen's heuristics and SUS.

5.4 Establishing Requirements

When establishing requirements, it is important to know who the users are, what to implement and how to implement. The two different sets of requirements include functional requirements, which capture what the product should do, and non-functional requirements, which regard constraints [36].

5.4.1 Functional Requirements

When determining functional requirements, it is necessary to understand what needs the user has. For that purpose, it was conducted an analysis of a social media platform for people affected by MS. The data consisted of their concerns and frequently asked questions during the last four years. The data from the analysis can be grouped into the following categories: *symptoms, MS and life, social life, medicine and treatment, climate, food and nutrition, bad habits, improvements* and lastly *more information*. Figure 9 was created to visualize the data and their relations.

The application needs to

- display what a user should do to get a healthier lifestyle (food recipes, supplements overview, exercises, mental health)
- store information the user wants to remember
- inform about different treatments and medicine
- store symptoms
- display easy exercises
- inform about frequently asked questions
- display other information regarding MS (advice on available help, dental care, pregnancy)
- store information about how a person with MS feels

5.4.2 Non-Functional Requirements

The non-functional requirements are the aesthetics of the application, providing constraints on the system and the development [34]. With this in mind, a simple interface was designed with the following non-functional requirements:

The interface needs to

- be user-friendly (no extra buttons, fast responding time)
- be aesthetically pleasing to look at (modern visual design)
- be designed for different devices (responsive, working on mobile and web)
- be design with a high-fidelity prototype within June 1st.

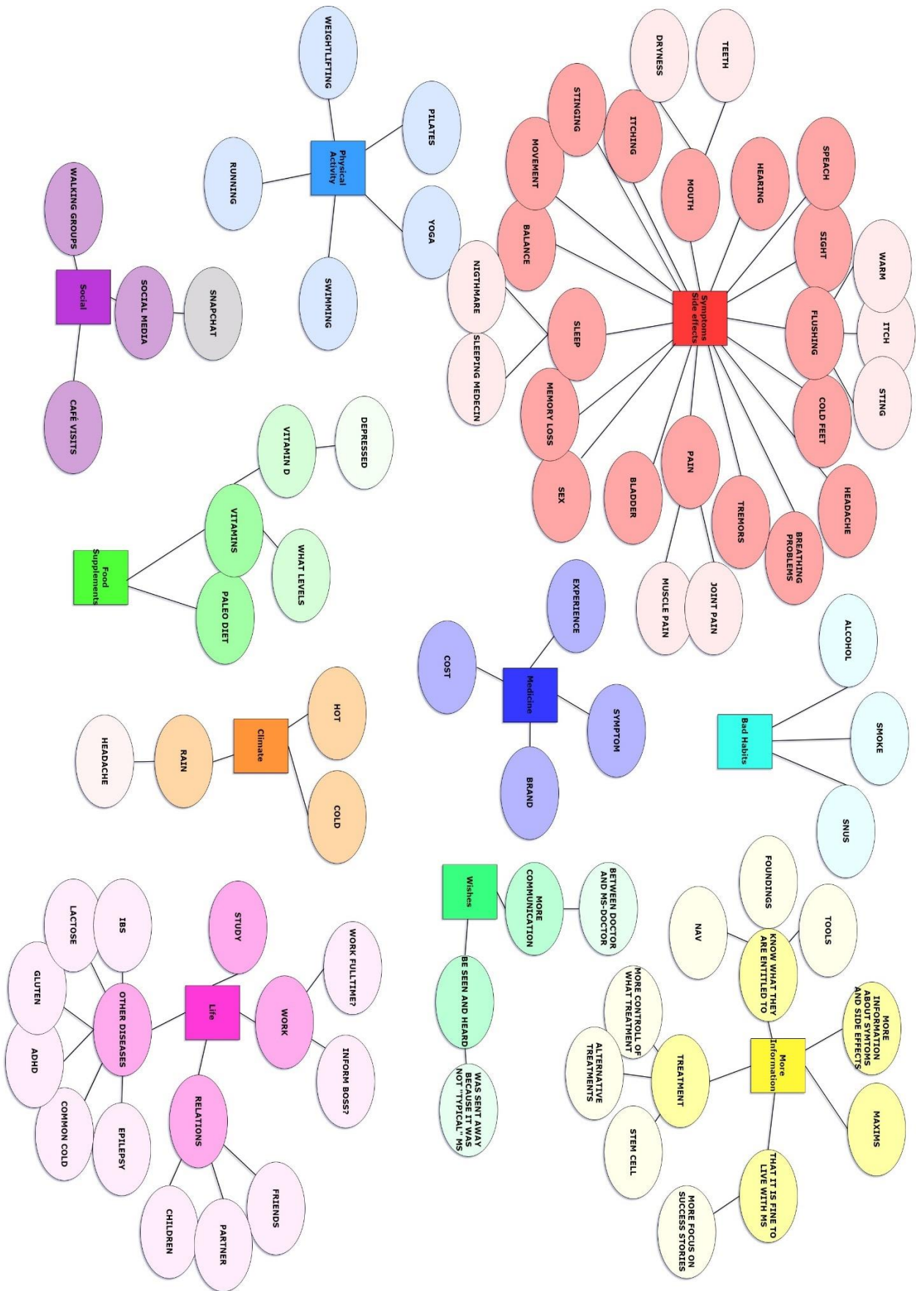


FIGURE 9: DATA STRUCTURE AND VISUALIZATION RESULTING FROM THE SOCIAL MEDIA PLATFORM ANALYSIS

Chapter 6

Prototype Development

This chapter is presenting the development tools used when designing and creating the prototype. It will also go in depth about all the iterations and methods used when prototyping the application.

6.1 Development Tools

6.1.1 ReactJS

ReactJS is a JavaScript library for building user interfaces [43]. ReactJS is one of the most used JavaScript frameworks and a popular front-end tool in 2018 [44]. Facebook, Instagram, Netflix, and PayPal are some of the websites and applications that are using ReactJS. It is easy to learn for both developers and designers as long as they have prior knowledge of HTML, CSS, and JavaScript.

6.1.2 GitHub Desktop

GitHub Desktop is a source control tool helping developers document and show the timeline of the project. The timeline makes it easy to track and retrieve earlier versions if mistakes or bugs are identified. Another advantage is that the tool helps experiment with different versions of a document while maintaining the original version [45].

6.1.3 Firebase

Firebase is Google's mobile platform that helps developers to quickly develop high-quality applications [46]. Firebase provides tools and functionality making it easy to store and upload information. For the application of this project, there are databases where the users can store information on Firebase about their symptoms, medications, and concerns.

6.1.4 Netlify

Netlify runs, builds, deploys and hosts the front-end application as a website, making it easy to have user testing on a mobile device. Netlify can link to many different tools, including the GitHub Desktop repository. Each time a change is made and pushed, Netlify will automatically build and deploy the new version [47].

6.1.5 Adobe Photoshop

Adobe Photoshop is a graphics editor making it easy to create and enhance photographs, illustrations, and 3D artwork [48]. Adobe Photoshop has been used to create new versions of conceptual models and low-fidelity prototypes.

6.1.6 Draw.io

Draw.io is an online diagram editor that makes it easy to create flowcharts, UML, entity relation, network diagrams, mock-ups and more [49]. Draw.io had a big impact on the social media analysis and helped create visualizations and a conceptual model.

6.1.7 Atom

Atom is the text editor used during this project to write code in. It is a desktop application built with HTML, JavaScript, CSS, and Node.js integration. It runs on Electron which is a framework for building cross-platform applications using web technologies. Atom has a lot of great functions that made it easy to work with this project, it displays the structure of all the files in the project and it is easy to search and edit code across files as well as an autocomplete function [50].

6.2 The Iteration Overview

Table 5 summarizes all the design iterations during this research, in terms of methods, outcome, and stage of development. It follows the UCD process (Figure 4).

Iteration	1	2	3	4	5
Define/ Redefine	Define Literature review/analysis	Redefine after experts	Redefine after SUS and survey	Redefine after case study and usability testing	Redefine after SUS
Fidelity	Low	Low/Mid	Mid	High	High
Method	Interview with experts	Focus group and design principles	Case study		Interview with experts
Evaluate	Evaluated by experts	SUS with experts	Usability testing	SUS with users	Nielsen's heuristics

TABLE 5: USER-CENTERED DESIGN IN STEPS

6.3 First Design Iteration

The first design iteration followed the model from the user-centered design process and had an overlap with the design science research methodology. Both methodologies share a concern for developing relevant and user-centered artifacts, for which they consider the environment and knowledge base a starting possession of the project. Only a well informed and sound development has the potential to meet user needs. The target group in this research was established to be young adults recently diagnosed with MS, before identifying requirements for the application. The requirements were established after conducting a literature review (Chapter 3) and analyzing a social media platform (Figure 9).

Design solutions were created, starting with a conceptual model, which followed by low-fidelity prototype versions where the interactive prototype was created with the framework Ionic. The design was evaluated and discussed with medical experts of the Norwegian Multiple Sclerosis Competence Centre at Haukeland University Hospital.

6.3.1 Social Media Analysis

The social media platform was a Facebook-group for people with MS in Norway, called "MS-Venner" [51]. The data analyzed was collected within the period from 2015 to 2019. Displayed in Figure 9 are the data categories regarding the concerns and frequently asked questions by the users during the last four years. The analysis proved that information regarding MS is sought out at more places than the

doctor's office. The results from the analysis were used to establish user requirements seen in Section 5.4 and to design a conceptual model (Figure 20).

6.3.1.1 Symptoms and Side Effects

The biggest part of the discussion on the platform was concerning whether other user had experienced similar symptoms. They were especially interested in symptoms possibly related to MS, side effects of medication or other factors. This helped form the features of the application where the user could read about medicine (Section 7.1) and get a bigger picture of what regular symptoms of MS are (Section 7.4).

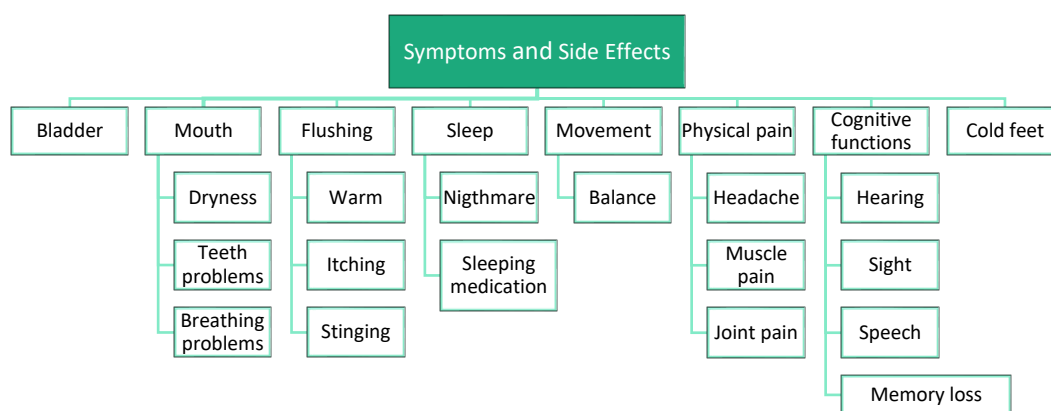


FIGURE 10: DATA CATEGORY - SYMPTOMS AND SIDE EFFECTS

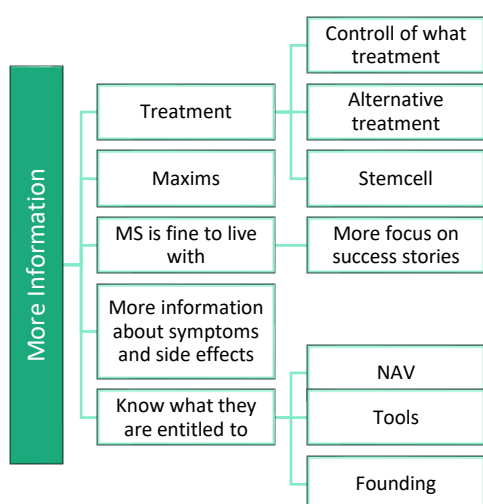


FIGURE 11: DATA CATEGORY - MORE INFORMATION

6.3.1.2 More Information

“More Information” was also a big part of the daily discussion on the social media platform. The users asked questions and gave recommendations from their personal experience. Requirements formed from this section resulted in multiple features where the goal was to display additional information regarding MS. This category is discussed further in Section 7.4.

6.3.1.3 Climate

The results from the analysis concerning climate did not have a big impact on the requirements, but it was mentioned in the application within the “information”-section of the application.

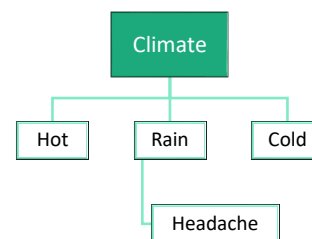


FIGURE 12: DATA CATEGORY - CLIMATE

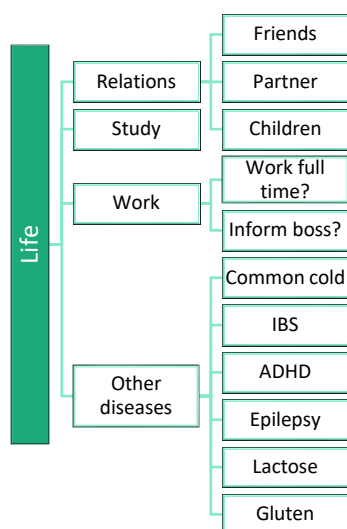


FIGURE 13: DATA CATEGORY - LIFE WITH MS

6.3.1.4 Life with MS

Most of the users, and especially those who are newly diagnosed, do have questions regarding everyday life tasks. Fatigue is extremely normal for someone with MS, which makes tasks which were once easy become a struggle. It is therefore important to know how to handle the energy.

It is a life changing experience to get the diagnosis which also impacts personal relationships and energy to manage them. After analysis, it was clear that the application needed a dedicated section to include information about MS and challenges (Section 7.4).

6.3.1.5 Bad Habits

On the social media platform, there are sometimes discussions about alcohol and how it impacts those with MS. Some mentioned that social events where alcohol is consumed demand a sort of preparation; one needs to charge up energy before and after such events. They are informed that smoking is bad, but some continue smoking. To address this issue, the idea for gamification appeared. Some feature should be implemented to score both good and bad habits, which will be discussed in Section 7.5.

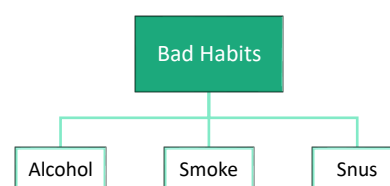


FIGURE 14: DATA CATEGORY - BAD HABITS

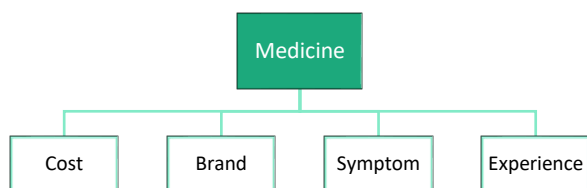


FIGURE 15: DATA CATEGORY - MEDICINE

6.3.1.6 Medicine

As mentioned, there is a feature of the application (Section 7.1) that will provide information about medicine since it was a subject often mentioned and discussed on the social media platform.

6.3.1.7 Social Life

MS, depression, and isolation are not uncommon. Many are wondering about places to talk, meet and interact. This need for communication was also identified during interviews with potential application users. However, the social function was not considered for implementation, since there are already platforms providing this service. Examples of this are the social media platform “MS-Venner” [51], MS-Snapchat for sharing stories, pictures and videos and MS group meetings that are being held by the local MS associations [52].

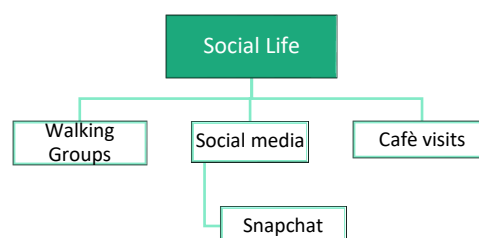


FIGURE 16: DATA CATEGORY - SOCIAL LIFE

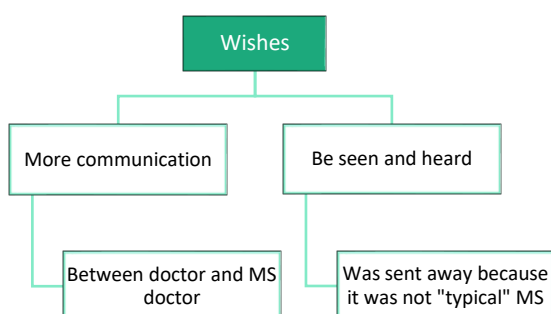


FIGURE 17: DATA CATEGORY - WISHES

6.3.1.8 Wishes

This category mainly regarded complaints about lack of communication and feeling ignored. This requirement was not implemented into the application, but rather discussed when talking to experts regarding options for future improvements.

6.3.1.9 Physical Activity

Regarding physical activity, it is often mentioned on the social media platform that fatigue is the biggest obstacle. Lack of energy makes it difficult to exercise, so many social media users of the MS platform were seeking for appropriate exercises that would be feasible for them to do. It is important to find ways to encourage exercise and give good and believable information (Section 7.2).

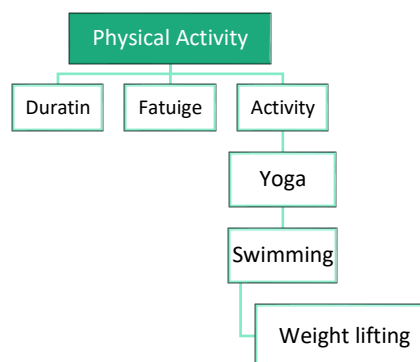


FIGURE 18: DATA CATEGORY - ACTIVITY

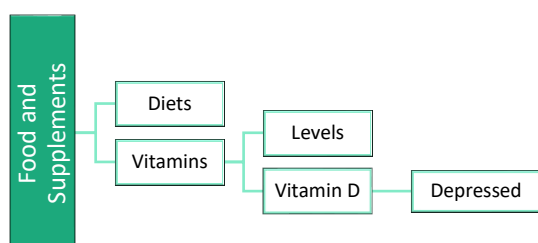


FIGURE 19: DATA CATEGORY - FOOD AND SUPPLEMENTS

6.3.1.10 Food and Supplements

Food and supplements were not included in the application since there is no significant evidence to point out the need for special diets (Section 3.1.2). This was later discussed by the medical experts at Haukeland University Hospital (Section 6.3.4) and confirmed that the nutrition aspect would perhaps not increase the quality of life for a person with MS.

6.3.2 Conceptual Model

A conceptual model is a high-level description of the application's outline and what a user can do with the product, as well as what concepts and *know how* are needed to interact with the application [36]. Figure 18 shows the concepts of the application including its structure and interaction points. Experts in the field of medicine and physiotherapy should contribute with reliable information. It is important to use recognizable icons and methods that are familiar on smartphone applications, such as a plus sign to add information, a trashcan to remove and a standard hamburger menu, as it is shown in Figure 20.

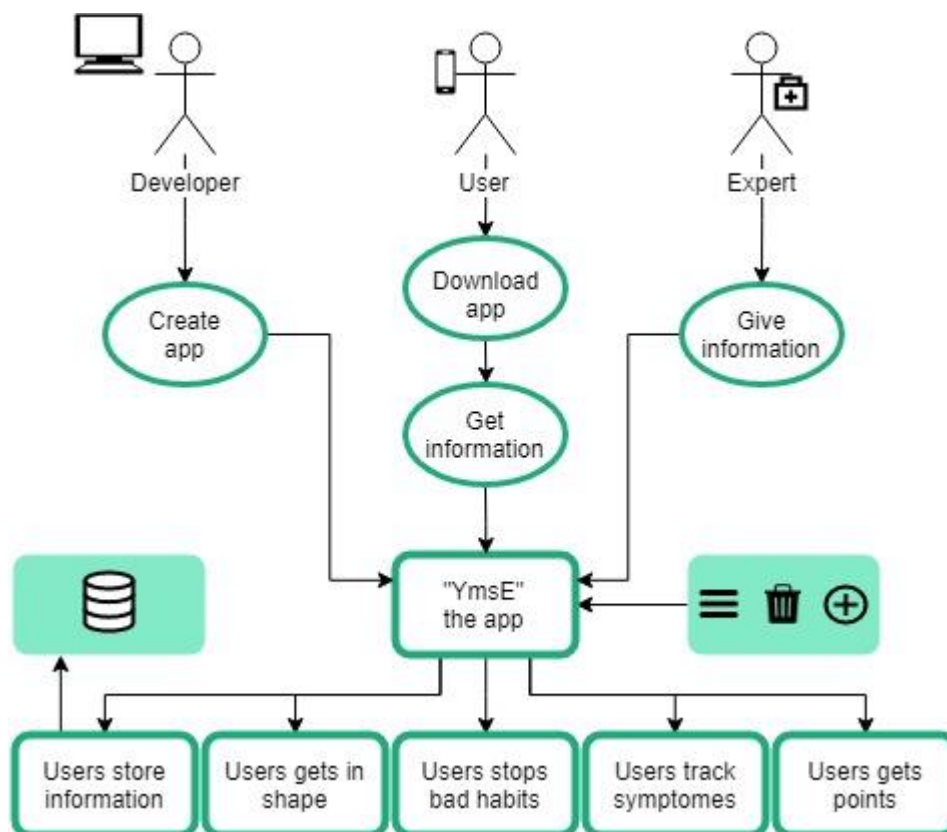


FIGURE 20: A CONCEPTUAL MODEL

6.3.3 Low-Fidelity Prototype

6.3.3.1 Sketch, Wireframes and Mock-up

The first versions of the application were created on paper and with photoshop as low-fidelity prototypes. Several versions were drawn on paper to test out different layout options. The main functionalities included in the sketch were a *health section* with information about medicine and tracking symptoms and vitamin levels, an *exercise section*, with a video of a workout suitable for a person with MS. Additionally, there is a section for *frequently asked questions* and a *list section* to capture all information between doctor appointments (memory can be affected by MS). Then there is a *food and supplement section* and lastly a *calendar* where both medical experts and users could communicate since it was often discussed that a person with MS would not receive documents by default but rather by request after consultation. Both food and supplements and calendar were removed after evaluation by experts and users, respectively.

Figure 21 is first showing a hand-drawn sketch with a grid system of displaying buttons on the main page. Second are three wireframes suggesting what action would be triggered by pushing buttons on the main page. For example, pressing the health button leads to the “Helse” page, with three additional choices. The same goes for pressing the exercise and questions, leading to the exercise page with the option to watch a video and to the frequently asked questions section, with information. Lastly is a mock-up created in photoshop with color options and illustrations of the main landing page.

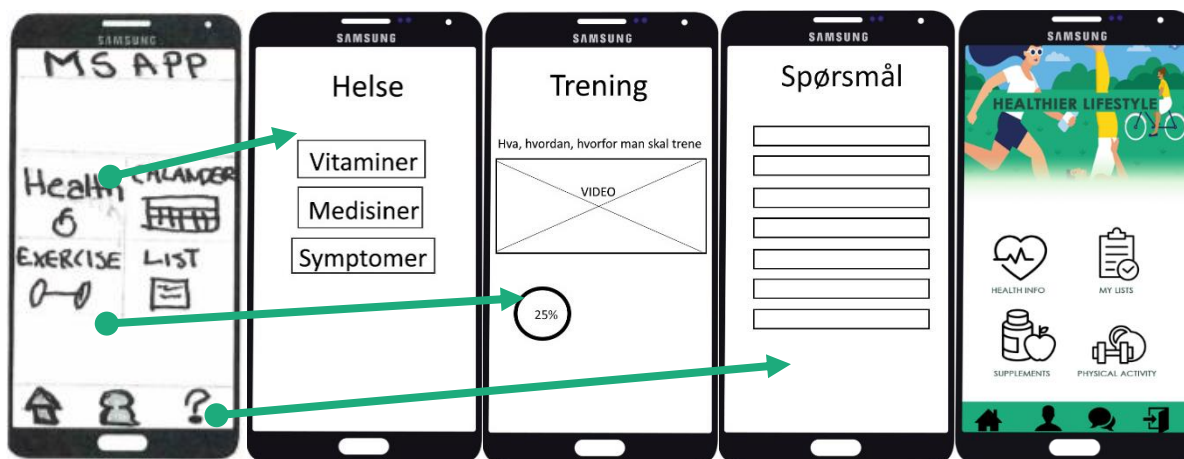


FIGURE 21: A SKETCH, WIREFRAMES AND A MOCK-UP

6.3.3.2 Interactive Prototype

Before using ReactJS as a framework, the framework Ionic was used. Ionic created the first interactive low-fidelity prototype (Figure 22). Instead of presenting the buttons as a grid system the application features were presented as a clickable list system with descriptive information and symbols to help illustrate the function of the button. The interactive prototype still displayed the same functions discussed in Section 6.3.3.1. Due to certain development limitations with the framework, the layout changed. The colors of the application also went from green to orange, which is the color symbolizing MS. The idea is to make the application recognizable and therefore the connection to MS should be more obvious, by using familiar colors. The name *YmsE* was introduced at this point, the word “ymse” is an easy and known Norwegian word and containing at the same time the contraction of Multiple Sclerosis in the middle. The word ymse has multiple meanings with some of them being *diverse*, *different* and *something*.

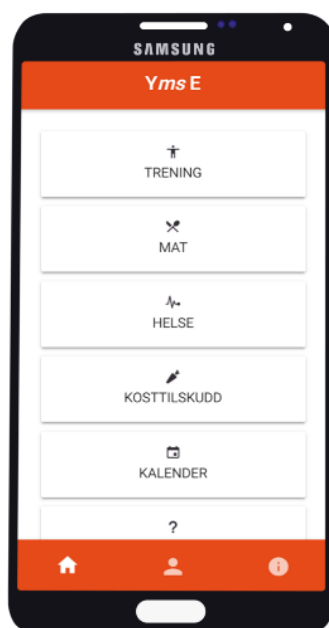


FIGURE 22: LOW-FIDELITY PROTOTYPE WITH IONIC

6.3.4 Expert Interview

Three employees at Haukeland University Hospital were interviewed, an MS specialist doctor (neurologist), an MS specialist nurse and a specialist MS physiotherapist. First, there was a brief presentation of the project, which included goals and ideas about how to accomplish the research project. Then the medical staff was introduced with the social media analysis (Figure 9) which they found insightful and requested a copy to be mailed to them after the meeting. Lastly, there was a semi-structured interview where a set of pre-defined questions about future development and features of the application were discussed.

The experts found it to be an interesting project and agreed that it could become a valuable source of information for users but in cooperation with medical experts and perhaps Helse Vest IKT department. There was also a discussion about whether the food-section was necessary for a person with MS, which was then discarded. As mentioned in Section 3.1.2, there is not enough proof that certain diets are impacting persons with MS in any positive way, so it would be hard to recommend anything else than a healthy and balanced diet.

6.3.5 Proof of Concept

After conducting the literature review, it was clear that an MS application for young adults in Norway would demand its own design requirements and further research conducted. Users have voiced an opinion regarding the need for developing a dedicated application fitting for their own needs. The medical staff at Haukeland University Hospital liked the idea of an application doing more research about MS and exploring design and technology solutions.

6.4 Second Design Iteration

The second design iteration consisted of changing framework, implementing and redefining requirements after feedback from experts followed by creating a new low-fidelity interactive prototype in ReactJS. Thereafter, the social media focus group was contacted to conduct a survey. Afterward, the design principles were integrated, and usability experts performed a SUS evaluation.

6.4.1 Redefining after Feedback from Medical Experts

After the semi-structured interview with the medical experts at Haukeland, some changes were done. One regarded the framework Ionic, which was replaced with ReactJS, due to IT experts recommending the latter as a better framework. ReactJS is heavily used and one of the most popular frameworks. The change did not cause any major issues since parts of the code could be reused, however, the change demanded some learning time. When using Atom, it was easy to transfer the usable code between the Ionic-project and the React-project.

The food functionality was finally removed, due to the feedback from experts and results from the literature review.

6.4.2 Low-Fidelity Wireframes and Interactive Prototype

New wireframes with a mix of mock-up were created to be more realistic and using the orange MS color. The information was again divided into four categories on the main page. As previously, by clicking one of the buttons on the main page, the user would be redirected to one of the four subpages displayed in Figure 23 in chronological order.

A new interactive prototype was created again, but this time in ReactJS. The design choices and layout were created exactly like the wireframes, but with the functionalities.

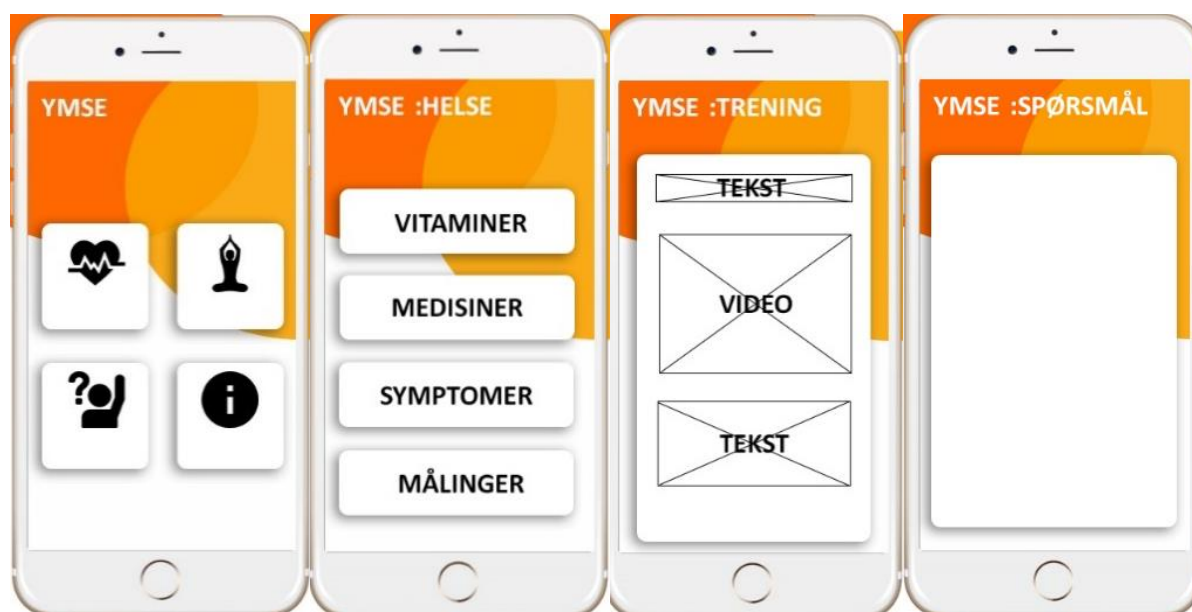


FIGURE 23: WIREFRAMES FROM THE SECOND DESIGN ITERATION

6.4.3 Social Media Focus Group

The focus group consisting of four females and two males, who were contacted over Facebook. After discussing problems relating to MS, the group was asked to take a survey individually with questions about the content and design of the application.

The first part was dedicated to design preferences. They were asked what sort of applications they use on a regular basis and why. Almost all of them mentioned Facebook, Messenger, and Snapchat because of intuitive UI and to stay social. When asked about color preferences they agreed that a light background with dark text was the best option, but that there should be some colors integrated as well. It was also important with a large font that was easy to read.

The second part was dedicated towards content they would like to see from a health and lifestyle application. They were presented with a list of features (calendar, workout, notes, a health section, a counter, and frequently asked questions), which were all gathered from the first design iteration. They were asked if there were more features they wished for and whether they would like to remove some of them. As an extra feature, there was a wish to implement a place where “embarrassing” questions could be asked anonymously. They suggested a place to display “whom to contact” with numbers and locations of MS care providers or organizations. They also wanted a place with information about MS that could be provided to family, friends, and colleagues. It was mentioned in the survey that the health section

would display information about medicine, but some of the users also wanted to track their symptoms and read about other side effects. Two functions mentioned by the focus group had already been discarded by experts in an earlier iteration but seemed to be of interest according to this focus group. They suggested a new social platform integrated into the application and a food function with recipes and a calorie counter. The first functionality would be too big to implement and in Section 6.2.1.7 other reasons to put this function on hold was explained. The majority found a calendar function redundant.

6.4.4 Reviewing Design Principles

To create a better mid-fidelity prototype, the five design principles (Section 4.3) were carefully reviewed to make sure they were all integrated into the current application design. Below are some examples of design features implemented to create a good and intuitive UI.

The first principle is *visibility* and an example of it was achieved by adding text under the icons on the buttons to ensure that the users would understand what they were pressing.

The *Feedback* principle was accomplished by using a pop-up informing the user what the action they performed had achieved.

To make it harder for a user to make mistakes, *constraints* were implemented. Figure 24 displays a constraint appearing as an orange text on the menu, insinuating that the user is on the page “5-min” and should, therefore, press another option on the menu. This constraint is normally referred to as a “breadcrumb” menu.



5-min | 10-min | Min trening | Tøying

FIGURE 24: BREADCRUMB INDICATING WHERE THE USER IS

The *consistency* of the design surrounding the application was implemented by using the same colors, fonts, buttons, and icons throughout the application.

Affordance was heavily used with the help of common icons as well as a recognizable layout matching the industry standard.

6.4.5 SUS with Usability Experts

The evaluation of the third design iteration was done by the three usability experts. They all came to the University of Bergen where they were presented with the application. The application was shown on a computer but with the responsive window of an iPhone 5/SE. After going through the application and explaining the functionalities, the experts had 2 minutes to go through the application by themselves. Since the evaluating was not done on the intended device, the results might not have been optimal. They all had a SUS score above 75 which is considered *good* and corresponds to the grade “C” (Figure 7). Some of the feedback was about implementing unfinished functionality such as a range slider, where the user could track information about the mood of the day. They were supposed to apply even Nielsen’s heuristics after the SUS, but due to problems with scheduling, it was postponed to the fifth design iteration. The results from the SUS is displayed in Section 8.2.1.

6.5 Third Design Iteration

In this iteration, the feedback from the focus group and usability experts was integrated and the application was connected to the database Firebase. A case study was conducted with two users, who tried the application and later evaluated it with usability testing.

6.5.1 Redefining after Feedback from Users and Usability Experts

Based on the focus group feedback and SUS evaluation by experts, the first change was to implement the suggestion of the “whom to contact” page. A mix between a wireframe and a mock-up was created (Figure 25), before integrating it into the mid-fidelity prototype using ReactJS. As the calendar function was not fully implemented, it was easy to remove it after the focus group found it redundant.



FIGURE 25: A WIREFRAME OF INFORMATION ABOUT WHOM TO CONTACT DEPENDING ON LOCATION

The feedback from the usability experts was good, but some issues were identified. The first goal was to get a more intuitive application by integrating functionalities. To achieve that, the Firebase database from Google was integrated into the application. Displayed in Figure 26 are examples of interactions between users and the device, where users get to store important information for later use.

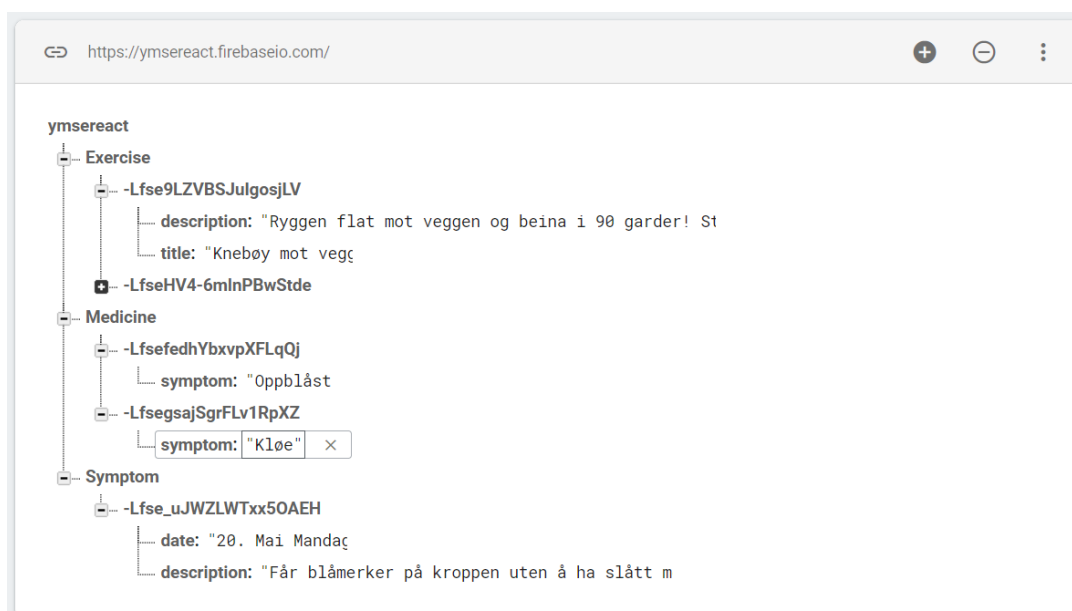


FIGURE 26: THE DATABASE ON FIREBASE

6.5.2 Case Study with Users

There were two participants in the case study who were contacted separately. The users (Section 5.3.1) consisted of a 26-year-old female (U1), finishing a master's degree who was diagnosed in 2016 and a 29-year-old male (U2), with a master's degree, working full time, whose diagnosis was established in 2018.

The users were told to play around on the application to get to know it. They were told to go through every page and explain out loud what their thoughts were. They were not informed if they managed to find every page or not. Whilst observing it was clear that U1 used her time and went systematically through every function, whilst U2 used a more hectic system, switching between using the hamburger menu and the main landing page menu. U2 did therefore not manage to visit all the pages. Both users mentioned that they felt the menu placement should be moved from the left side to the right. U1 also expressed displeasure with the background color. After they were done exploring the application, they were asked some questions as well. Table 6 is a summary of the questions and answers from the case study. From that, it was clear that they agreed that the design was good but could be improved. The background was changed to a gradient (Figure 30), the font was changed (Figure 31), the menu was moved, and the grid went back to a list. U2 expressed that information should in the future be marked with quote and validity. Information on the medical exams could be compressed when appropriate (e.g. "read more"-button). They both disliked push notifications in the form of reminders (e.g. taking medication). An MS-Dictionary was implemented after U1 suggestion it. U1 meant that there could never be enough content, whilst U2 meant that too much information could make it hard to navigate through.

	U1	U2
Color Choices	Enjoys the oranges. Finds it suitable, since the MS-color is orange as well.	Not much to say, I like it.
Font Style	The font is fine, but perhaps a little bit plain.	Really do not like Arial, such a boring font.
Font Size	Did not think about it, easy to read.	I have some problems with my vision, maybe have an option for people to scale up if needed.
Illustrations and Icons	Could add in pictures of how an MRI-machine and so on looks like.	More icons and less text.
Quantity of Information	Can never have too much information. One day “this” is important and another day something else is important to check.	The problem with too much information is that it can be disorganized to find what you need.
Quality of Information	Was good, but some information can be heavy, and you should add in a dictionary of common MS-related words.	Should be clear that sources are from the health care personnel.
Balance Between Disease and Lifestyle	It could focus more on lifestyle. Add in recipes that are easy to follow. I do not have the energy anymore to plan out fancy and healthy recipes. With workout, I would like stuff I can do while I’m cooking, brushing my teeth and so on, don’t have the time for 1-hour workouts.	As of now, there was more on the diseases part, but I like it that way.
Improvement	The menu should be on the right side?	Change the hamburger menu to the right and have the back button on the left. Also, do not have a submenu it creates too much clutter.
Dislikes	Reminders to take pills are like a notification that yells “Hey, you have MS” and I don’t want that reminder every day. Do not feel like I would use a range slider, but maybe a color code? Just push one button and see a calendar of how colorful a month was.	Push notifications, I will uninstall if an app uses it and it cannot be switched off.

TABLE 6: A CASE STUDY WITH USERS

6.5.3 Usability Testing with Users

The participants of the case study performed usability testing in the third design iteration. The users came to the University of Bergen on two separate dates to take the test individually. The test was performed on a computer, but with the responsiveness of an iPhone 5/SE. They were presented with seven tasks and told that they would be timed on each task. Both users were familiar with the application and had navigated through it prior to the test. The UI seemed intuitive and the users did not make any mistakes. The result of the usability testing is displayed in Section 8.3.

6.6 Fourth Design Iteration

In the fourth design iteration, information from the case study and usability testing was integrated. The application was deployed by using Netlify to help improve a high-fidelity prototype. The users evaluated the application with SUS.

6.6.1 Redefining after Feedback from Users

A lot of useful information was gathered from the case study and usability testing. Some of the changes were to remove subcategories under the hamburger menu and the measuring function with sliders. A “read more” option was implemented and can be seen in Figure 27, respectively. All these changes helped in creating a high-fidelity prototype.



FIGURE 27: A «READ MORE» - OPTION IMPLEMENTED ON THE RIGHT SIDE

6.6.1.1 Integrating Netlify

To get the project to work with Netlify, a new project had to be created due to problems with the libraries. The code from the initial project was copied over to the new project requiring no changes except for excluding unused libraries. Due to this, the source control and documentation were split between two projects, however, this was accepted as a necessary step to prioritize deployment over documentation. Problems with routing occurred, but they were easily fixed as it can be seen in Figure 28.

Netlify made it easier to display the application on the intended device. Every time changes were made and pushed with GitHub Desktop, they were automatically pushed on Netlify, as well (Figure 29).

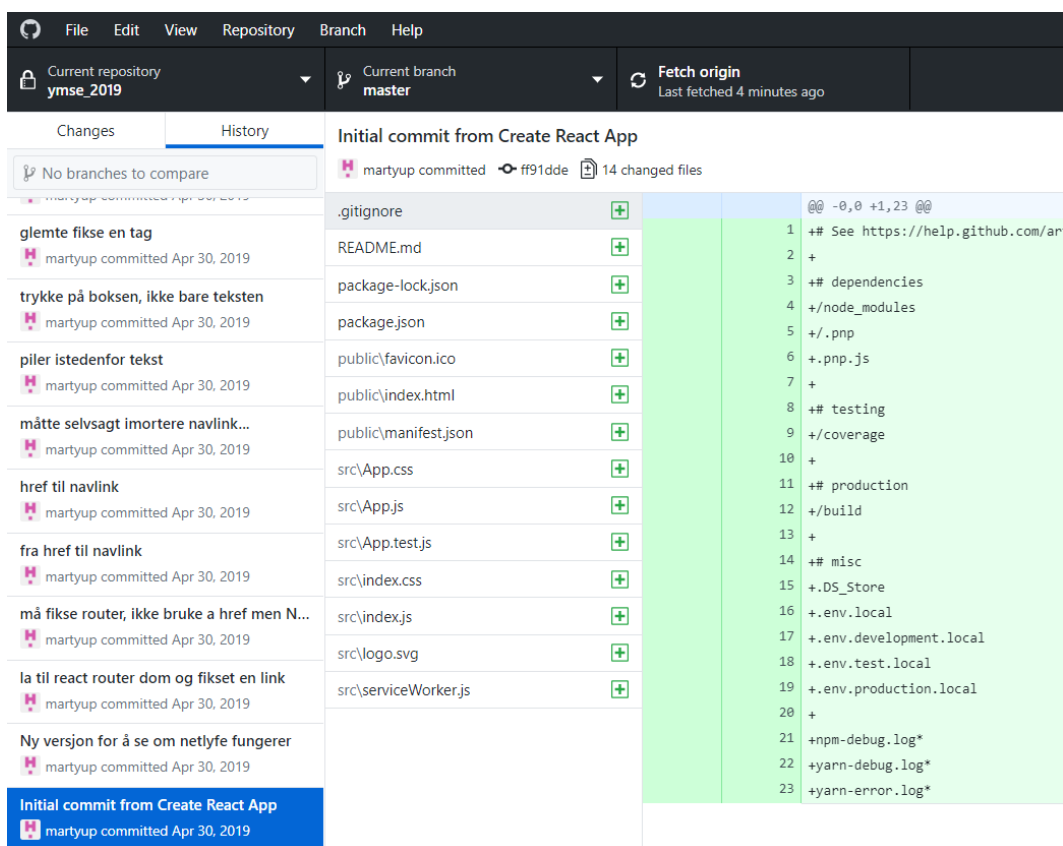


FIGURE 28: GITHUB DESKTOP - SOURCE CONTROL

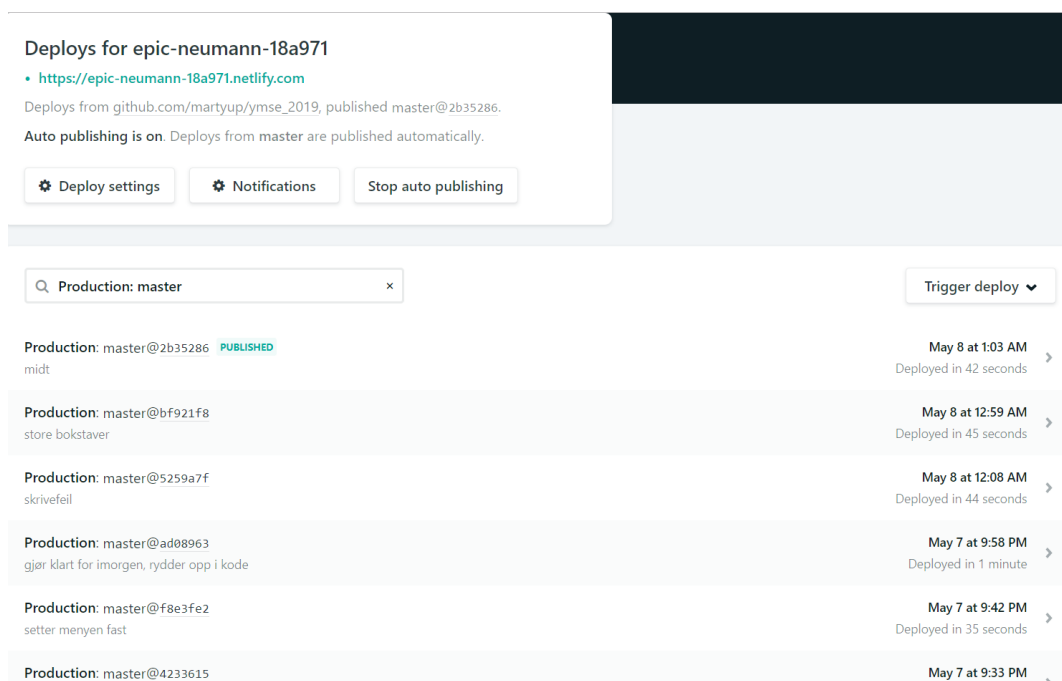


FIGURE 29: DEPLOYING WITH NETLIFY

6.6.2 Final Design Choices

6.6.2.1 Product Name

The product name YmsE was introduced in the first design iteration (Section 6.3.3.2). It got a lot of positive feedback from users, medical experts, and usability experts.

6.6.2.2 Color Scheme Choice

The color scheme was established early on, but at this point, it was finalized. The first color in Figure 30 was a deep orange used on icons to make them stand out. The next color is a gradient created with the first orange color and a yellow one, it was used as a background color throughout the application. The third color is a light grey that was used to create dimensions. The fourth color was plain white, which was used as a background for text fields. The last color is black, that was used for the text. It is easier for users to read dark text on a light background [53]. Considering MS can cause visual impairment, it is important to take this constraint into consideration.

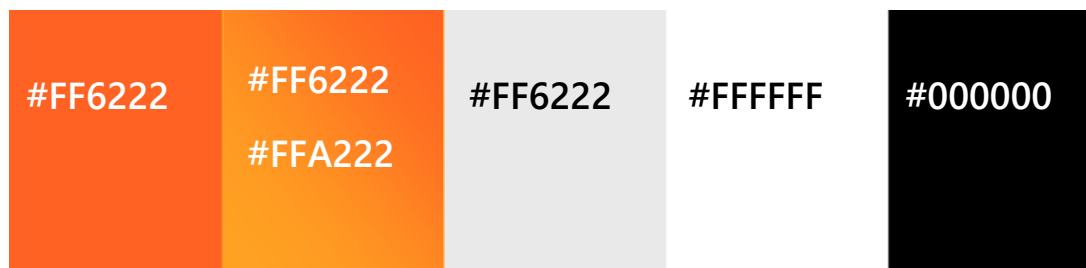


FIGURE 30: COLOR SCHEME FOR YMSE

6.6.2.3 Font Choice

The font used is called Montserrat and is a sans-serif type. The font was found on Google Font, which is a place where developers can integrate typography into any design project seamlessly [54]. Figure 31 displays the font used.

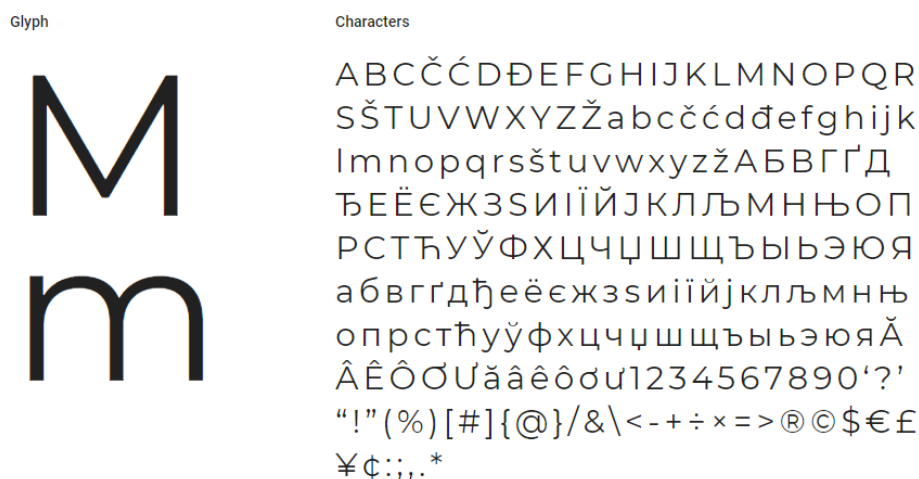


FIGURE 31: THE FONT USED IN THE APPLICATION YMSE

6.6.2.4 Illustration Choices

All icons used in the design process are from Font Awesome Free. Font Awesome is a free platform that shares icons that can be used for any commercial projects, open source projects or something else a developer might desire [55]. Displayed in Figure 32 are some of the icons that will pop up when searching for free icons about health and medicine. The icon “heartbeat” is one of the icons used in this project. To use well known and established icons will help with affordance and visibility for users.

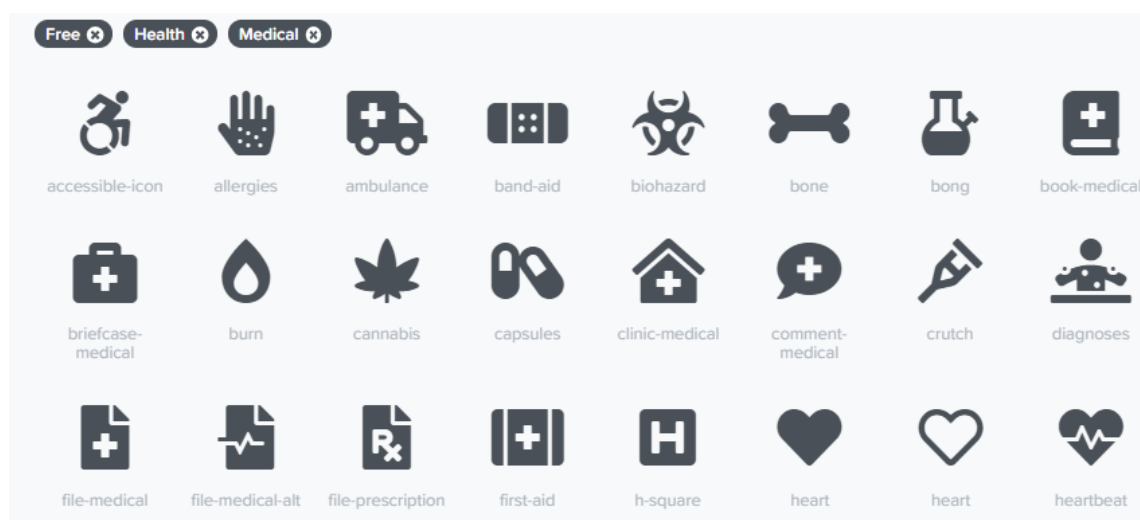


FIGURE 32: FREE ICONS FROM FONT AWESOME

6.6.3 SUS with Users

A SUS evaluation was conducted by the same users who contributed to the case study and usability testing. The users opened a link on their mobile device to go through the application before answering the SUS questions. The overall result was good and provided proof of improvement from the last SUS evaluation. They both got a SUS score above 90 which is a grade A. It would have been optimal to carry out evaluations with several more users, but unforeseen circumstances affected their availability.

Additional feedback from the users suggested adding a sorting functionality on the medicine page. It should be possible for users to have three different sorting options; alphabetical, the way you take the medicine and how often it must be taken. The second person (P2), with an IT background, was more critical than the first person (P1). The result of the SUS can be seen in Section 8.2.2.

6.7 Fifth Design Iteration

The fifth was also the last design iteration, which implemented results coming from the SUS. There was a second interview with medical experts, this time in the field of physiotherapy. Finally, the application was evaluated using Nielsen's Heuristics by usability experts.

6.7.1 Redefining after Feedback from Experts

The feedback from the users after the final SUS was positive, but there are still improvements left to be implemented in the future (Section 6.8) and they concern the high-fidelity prototype.

6.7.2 Semi-Structured Interview with Physiotherapists at Haukeland University Hospital

The last semi-structured interview was with four medical experts at Haukeland University Hospital, where one was an MS-nurse and three physiotherapists specialized in MS. They were all introduced with the new high-fidelity prototype. Two of them had seen the application in the first design iteration as a low-fidelity prototype.

A discussion surrounding the validity and possibility of having one short exercise program and one long exercise program was held. MS can affect every person differently, but a standard exercise program could be created according to the experts. Same could be said for the stretching program. They also liked the idea of a tailored exercise and stretching program that would be created together between patient and physiotherapist. A similar program called ExorLive [56] was mentioned as an example of such a solution. ExorLive is a system where physiotherapists, personal trainers, organizations and others can buy a product and share tailored programs with clients.

The physiotherapists also wanted to get the message across about safety and doing an exercise correctly. For this, the “basic page about exercise information” was created. They agreed that illustrations were important. A person needs to have prior knowledge from a personal trainer or physiotherapist to really know how an exercise should be executed and rather reminded by an illustration explain how to perform it. Another opinion was to have a search function within the dictionary as well, instead of scrolling.

6.7.3 Nielsen’s Heuristics with Usability Experts

The same three usability experts were contacted for conducting an evaluation with Nielsen’s heuristics. The users were sent a link that they could open on any device they wanted, but it was preferred for them to use a mobile device. The overall result was positive, but room for improvements reminds. The results of the evaluation are displayed in Section 8.4.

6.8 Future Design Iteration

After talking to users and experts, there were a lot of new functionalities that could be implemented in the next design iteration. Some features are easier to implement than others. The feature where a user can ask “embarrassing” questions is dependent on a collaboration with medical experts and is rather something to discuss in depth (Section 10.2). The same goes for the suggestion to integrate a social platform for people with MS. However, to add illustrations and pictures as mentioned in the case study would be no problem, same goes for an option to scale up the text of the application or to use a color system to track the mood. Results from the SUS evaluation also recommended implementing a sorting system on the medicine page.

Chapter 7

Features for YmsE

This chapter is an overview of the main functionalities of the high-fidelity prototype YmsE. Presented is the final product after following methodology and methods leading up to five different sections that the application is divided into.

7.1 Health Section

In the health section of the application, there is information about three subjects. It starts with *10 tips for a better lifestyle* to help increase life quality. The ten tips were formed after research and consist of remembering to relax, stretch the body, include activity, drinking water, get enough sleep, be social, not give up (with hobbies and so on), reduce bad habits, eat healthily and track the necessary. These tips will later be implemented into a point system (Section 7.5).

Next is *Notes for the next doctor appointment* (Figure 33), so the users can track symptoms and questions that are not urgent. Here the user can interact with the application by informing about the date and what the concern is about, which can be anything from a symptom to remember to ask about blood levels. It will be stored in the database Firebase. The user can also delete their note(s) after the appointment or if it is no longer a concern. There is also an option to be redirected to a page informing about common symptoms.

The last subject is *Information about medicine*, where the users can read about the different medication available in Norway. They can search for the medicine they use or for other options. Displayed with each medicine is; who it is best suited for, other names it goes by, the method (syringe, intravenous), the dosage and side effects. The user can also add and delete the side effects they have experienced when using the medicine. This section can be helpful if implemented further since valuable data from users could be collected on side effects of medication and energy levels over a longer period.

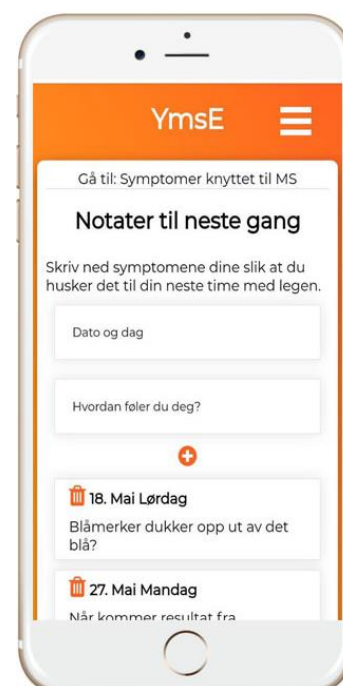


FIGURE 33: YMSÉ - NOTES FOR THE NEXT DOCTOR APPOINTMENT

This could enable further insight for users and research that medical staff would benefit from and perhaps have difficulties to collect otherwise.

7.2 Exercise Section

The exercise section consists of five pages, the first page is *basic information about exercise*. It is important to have common knowledge about how exercises should be done, but also how MS can affect the body when exercising or rather not exercising. Some might need to be extra careful about body temperature whilst others could be reminded that there is nothing wrong with taking a break or even stopping a workout.

There is a *short session* (Figure 34), and a *long session*, that displays a workout program with information of how to do an exercise, as well as illustrations (gifs) presenting the exercise. It is also implemented a stopwatch where the user can time an exercise.

Stretching exercises are also illustrated and explained since stretching does have a big impact on people with MS. It is something to be considered to do in the morning and evening.

Lastly, there is a page where the users can collaborate with a physiotherapist to tailor a program especially for them.

An option to track progress would be beneficial and should be considered for future implementations, and eventually shared with medical staff and researchers.

7.3 The MS Dictionary Section

The MS dictionary page consists of common words and phrases often heard in relation with MS that are explained in brief. This was one of the last features added to the application, as it was requested during the case study. One of the participants of the case study contributed to the implementation of the feature.



FIGURE 34: YMSE - A SHORT WORKOUT

7.4 Information Section

The information section is the biggest and consists of six subcategories. The first one is *information about support*, where users can read about what they are entitled to in terms of financial support, their rights at the workplace and during academic studies.

Information about whom to contact is a place where users can search for a county and get information about MS hospitals, MS nurses, neurologist or physiotherapist.

There is a page of information that can be shown to *people who do not have MS* but are affected by it, e.g. partners, family members, kids, workplace or friends.

One page is dedicated to the information that is *good to know*. The user can be informed about different places to stay where special MS care is provided. In addition, the users can read about how climate affects a person with MS, how it could affect pregnancy and how to live with other conditions and diseases e.g. epilepsy and chickenpox. There is information about dental care since MS medicine may damage the teeth and other links to relevant information regarding MS.

There is a page about *symptoms* one may experience with MS. They are divided into three subcategories consisting of physical symptoms, cognitive symptoms and challenges with mental health after the diagnosis.

The last one is *frequently asked questions*, with information about who gets MS, if it is a cure and other questions.

7.5 The YmsE Points Section

YmsE points is a gamification option design to encourage users to stop with bad habits and enforce new good habits. Figure 35 is displaying a score at the bottom of the menu, and when pushed, the user is redirected to a page with counters that would in the future become a point system. This feature is not yet fully implemented since it would require more work to outline a sound and meaningful scoring system with factors such as age, level of disability, good and bad habits and so on.

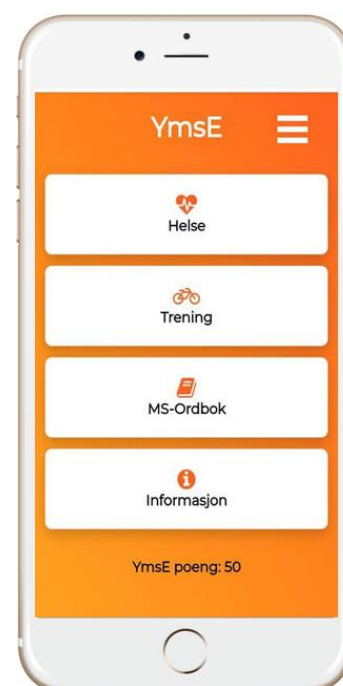


FIGURE 35: YmsE - POINT SYSTEM

Chapter 8

Evaluation

This chapter presents the evaluation results from four different design iterations (second, third, fourth and fifth) gathered from SUS, usability testing and Nielsen's Heuristics.

8.1 Participants

There were two different groups evaluating between each design iteration. It was switching between usability experts (Table 7) and the intended users (Table 8) of the application. The first group which consisted of usability experts (Section 5.3.3) have all gotten an IT related degree from the University of Bergen where they have taken many courses connected to human-computer interaction and interaction design. The second group is the intended users (Section 5.3.1) who have been diagnosed with MS.

Experts	E1	E2	E3
Age	27	24	28
Gender	Male	Male	Female

TABLE 7: USABILITY EXPERTS - GROUP ONE

Users	U1	U2
Age	26	29
Gender	Female	Male

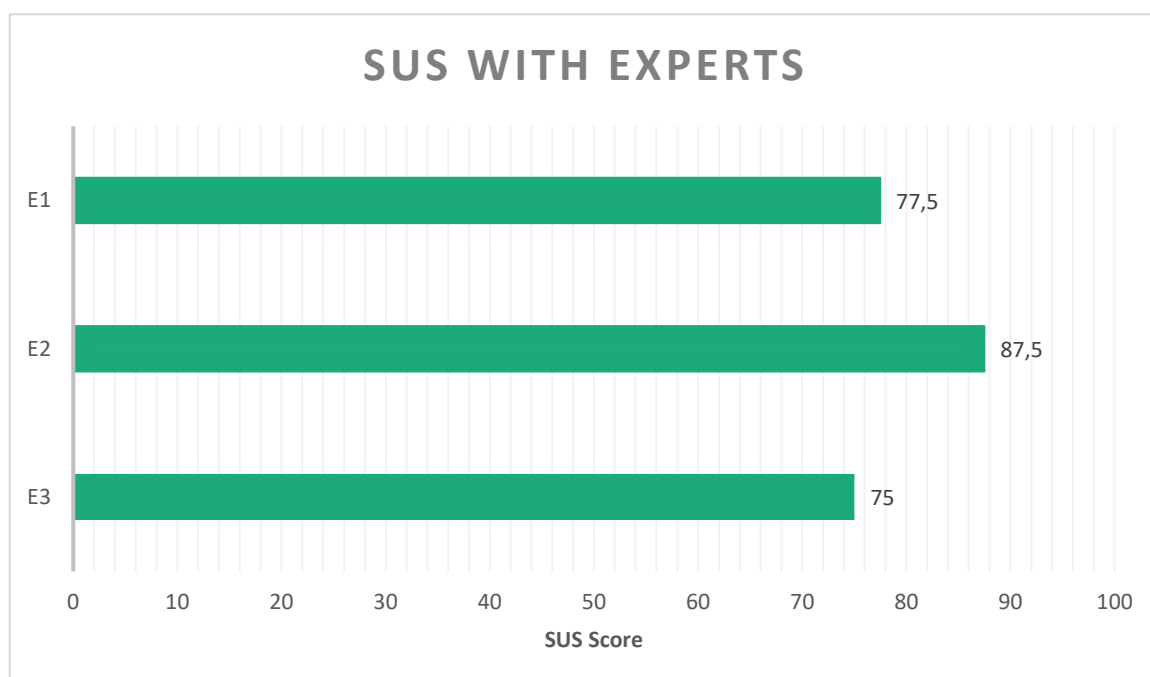
TABLE 8: USERS - GROUP TWO

8.2 System Usability Scale

There were two groups who evaluated the application with a System Usability Scale (SUS) method. The first group were usability experts and the second group where future users. The experts used a computer with the window of an iPhone 5/SE, whereas the users were sent a link they could open on their smartphone.

8.2.1 SUS with Experts

The usability experts took the SUS evaluation during the second design iteration when the implementation of functionality was still intensively ongoing. Every usability expert returned a SUS score above 75 (Graph 1). As mentioned in Section 4.5.2, a SUS score above 70 is given a corresponding grade equal to “C” or the adjective “good”. The experts took the evaluation individually, but they were in the same room.



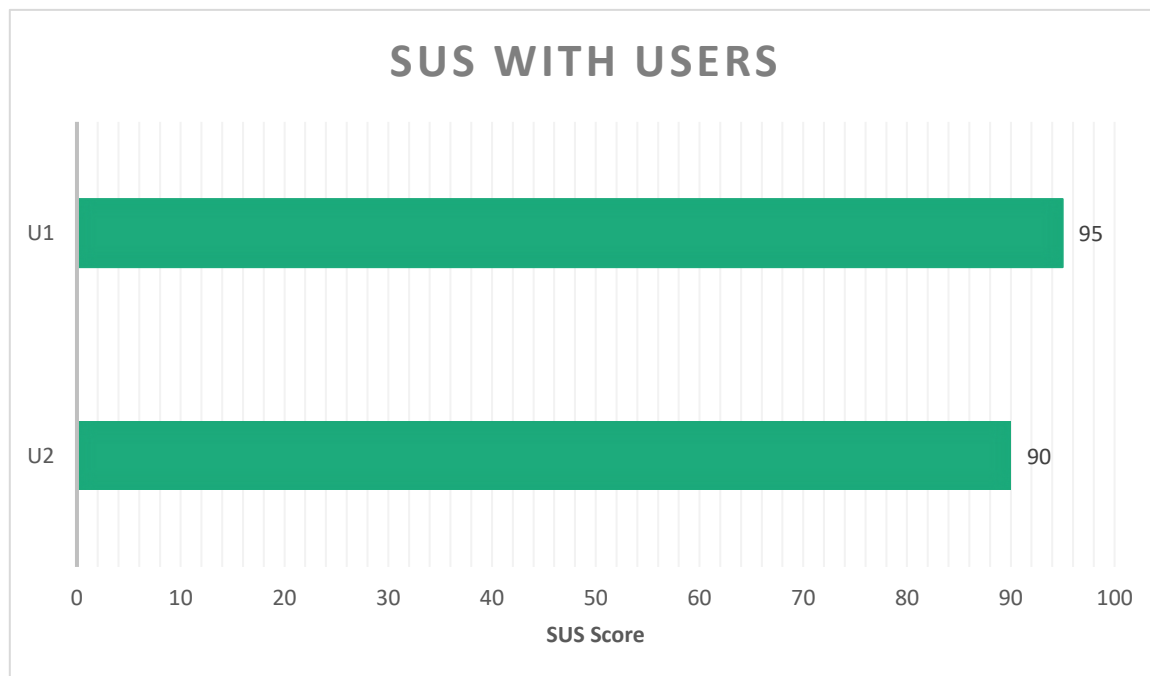
GRAPH 1: SYSTEM USABILITY SCALE (USABILITY EXPERTS) – THE RESULT

8.2.2 SUS with Users

The users took the SUS evaluation on the fourth design iteration. Both users got a SUS score above 90 (Graph 2). A score above 90 is considered to be equal to grad “A”, and above 90,9 is referred to as “best imaginable” (Section 4.5.2). The users took the evaluation on different days, with the same high-fidelity prototype.

The problems user one (U1) talked about was how frequently the application would be used in the future. U1 mentioned she would probably not use it every day, but rather a few times a week to track symptoms and use the exercise/stretching program. U1 is aware that stretching should be done in the morning and evening, but she doubted she would keep up with such an ideal program. However, she believed and hoped she would use it from time to time, as often as possible. User two (U2) expressed the same opinion

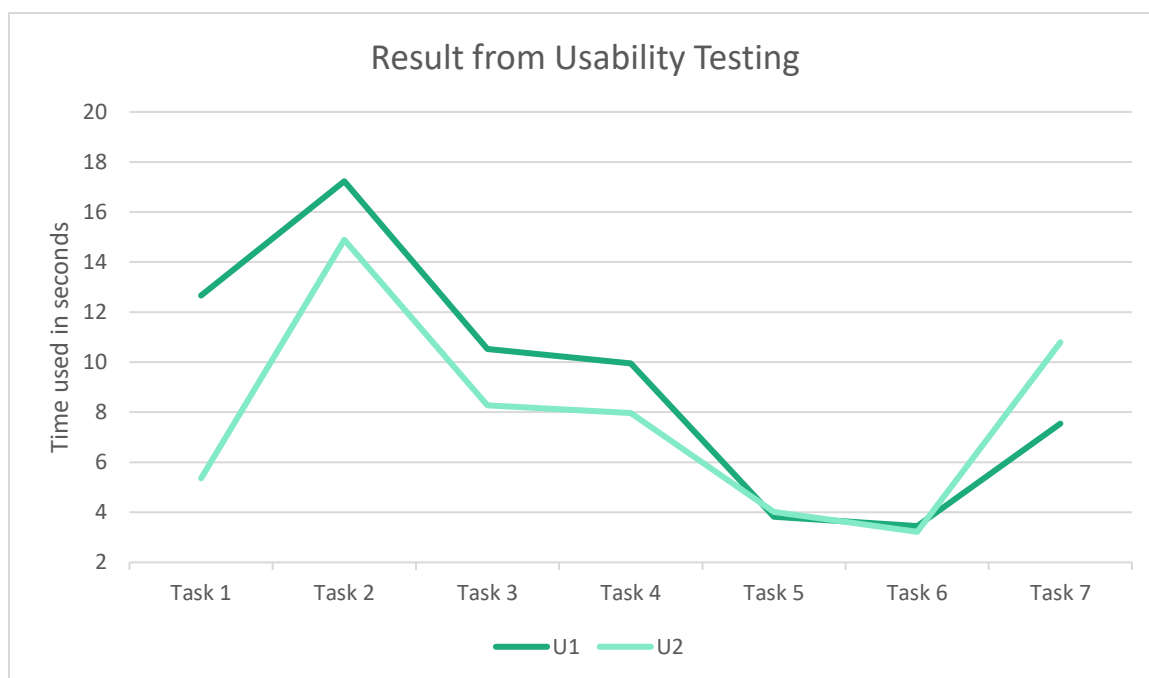
regarding frequency, but also that some of the functions should be integrated better. U1 suggested having a sorting method on the medicine page.



GRAPH 2: SYSTEM USABILITY SCALE (USERS) – THE RESULT

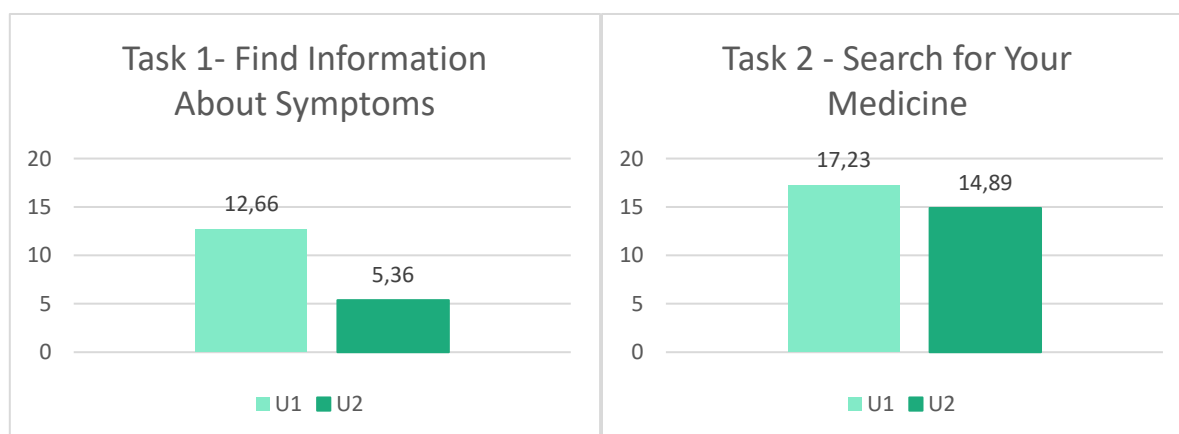
8.3 Usability Testing with Users

Two users were timed to find out how efficiently they could use the application. They had seven tasks to perform on a computer that mimicked the screen of an iPhone 5/SE. They were not given any instructions on how to accomplish a task, but they had used the application once prior to the test. The users managed to accomplish all the seven tasks without guidance (details follow in the text below). There was only one noticeable difference between the users, and that was how they navigated through the application. U1 would frequently use and click on the “YmsE” symbol on the top of the screen to go back to the main page and navigate from there. U2 on the other hand, preferred to use the hamburger menu to navigate, which proved to be a quicker option. The overall result of the usability test can be seen in Graph 3.



GRAPH 3: OVERALL RESULT OF USABILITY TESTING IN SECONDS PER TASK

Task 1 (Graph 4), was to *find information about symptoms* when the starting point was on the main page of the application. U2 used half of the time that U1 used. The reason for this that U1 first clicked on the “health - section” instead of the “information - section” which she explained was due to the stress of being tested. Task 2 (Graph 5), was to *search for the medicine they use*. The result was similar between U1 and U2.

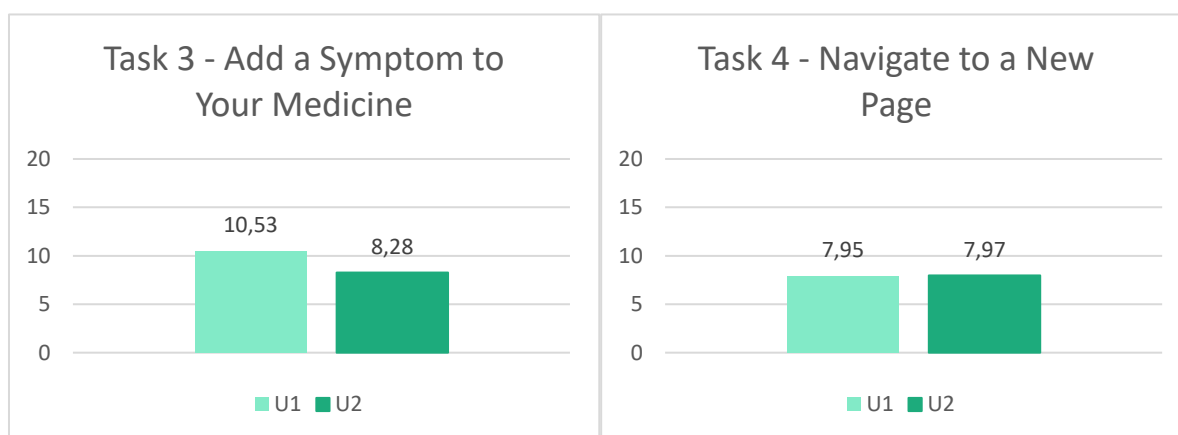


GRAPH 4 AND 5: USABILITY TESTING – TASK 1 AND 2

Task 3 (Graph 6) was to *add a symptom to your medicine*. Since they were both already on their medication, it did not take long for them to start typing. Time was spent on creating a message and they both understood they needed to press the plus button, to save the description of the symptom.

Task 4 (Graph 7) was to *Navigate to workouts*. They both started where they ended previously task. U1 scrolled up and pressed the “YmsE” symbol at the top of the screen, before landing on the workout button. U2 pressed the hamburger menu and went straight to the workout section, which is the quicker way, but he used some time scrolling up from his treatment that was further down on the list.

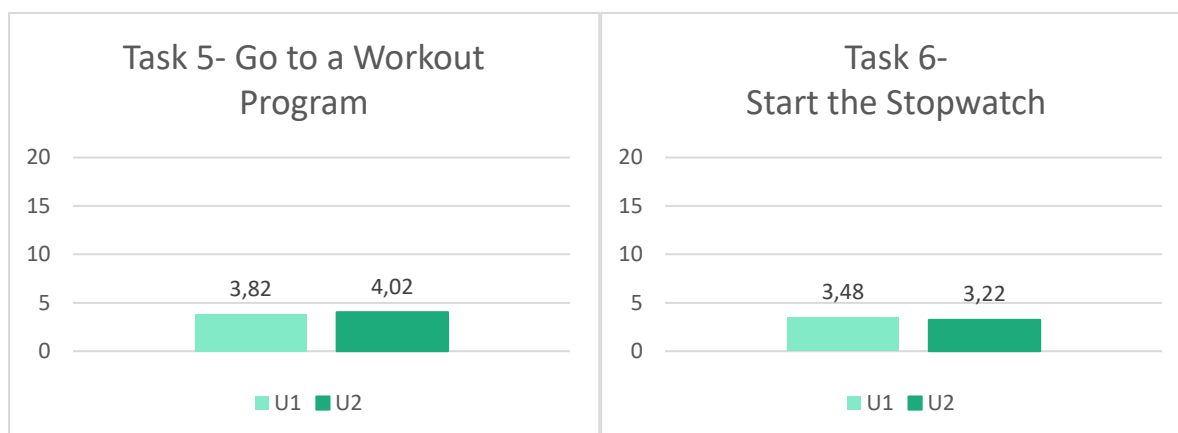
Since they used different medication, it caused some inconsistency in testing. It would be more objective to search for the same medication (in Task 3) to secure comparable results. However, the important point was that they managed to complete the task without errors.



GRAPH 6 AND 7: USABILITY TESTING – TASK 3 AND 4

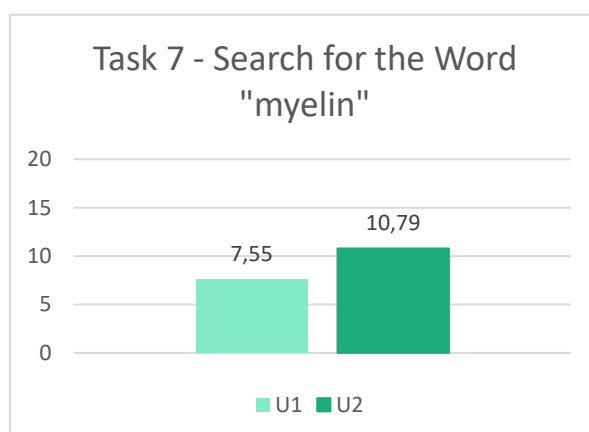
Task 5 was to *go to a workout program* (Graph 8). There was not much difference in the task other than U1 choosing the 5-minute workout and U2 choosing the stretching program.

Task 6 (Graph 9) was to *start the stopwatch* in the exercise program they had chosen. Both users managed to complete the task within seconds.



GRAPH 8 AND 9: USABILITY TESTING – TASK 5 AND 6

Task 7 (Graph 10) was to figure out *what the word “Myelin” means*. U1 went to the main page by pressing the “YmsE” symbol, then the MS-dictionary option before scrolling down to myelin. U2 started explaining the meaning since he was already familiar with the term, so had to be instructed to use the application. He then went to the hamburger menu, pressed MS dictionary and scrolled down. This caused a slight delay.

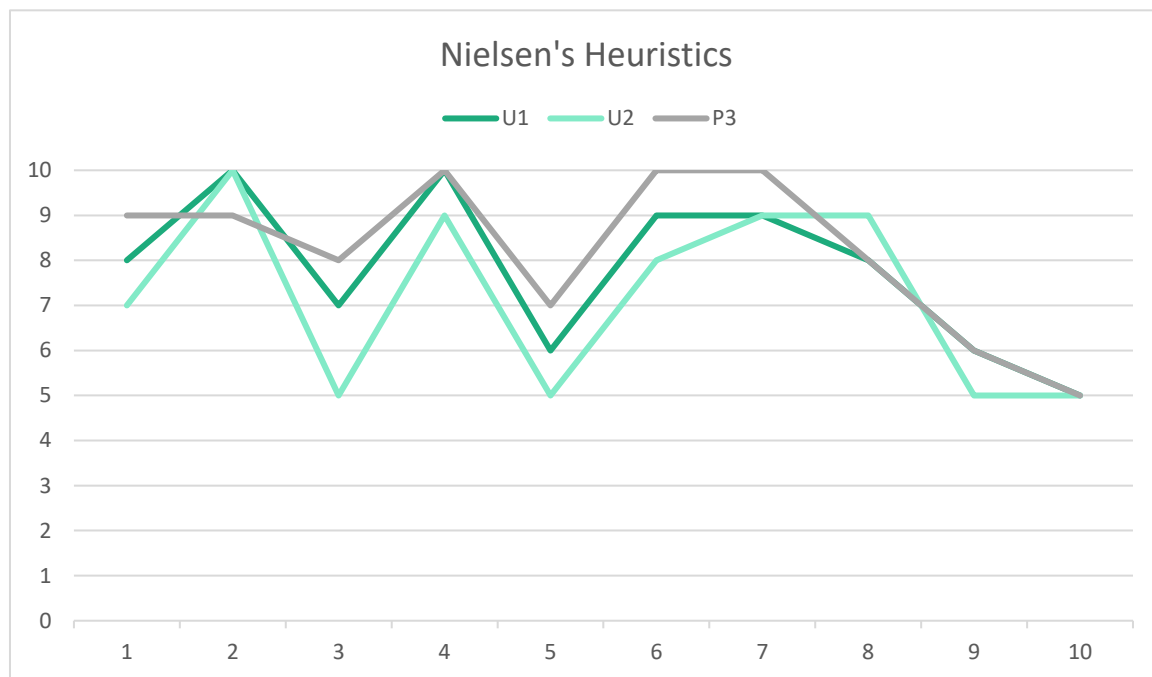


GRAPH 10: USABILITY TESTING – TASK 7

8.4 Nielsen’s Heuristics with Experts

Nielsen’s heuristics was the last step of the fifth and final design iteration. As mention in Section 4.5.3, one or two evaluators are enough at the beginning of development, but since this is the last evaluation, there should be between three to five experts to test the application to identify problems. There were three usability experts who performed Nielsen’s heuristic evaluation on the high-fidelity prototype.

They were sent the link to the application, all ten heuristics that would be evaluated (Table 3) and a summary of Nielsen's Heuristics. They all took the evaluation separately in their natural settings on their own smartphone devices. They were asked to give a number between 1 and 10, where 1 is the worst and 10 the highest score. Graph 11 displays the overall result from the evaluation and points out heuristic three, five and nine that should be improved. Below is an explanation of the feedback for all ten heuristics.



GRAPH 11: OVERALL RESULT OF NIELSEN'S HEURISTICS – USABILITY EXPERTS

(1) *Visibility of System Status* - The experts felt the user would be satisfied with getting information with appropriate feedback within a reasonable time, but they would like better-integrated feedback on both success of the action and the confirmation of fulfilling a task.

(2) *Match Between System and The Real World* - The experts were pleased with the language of the application and felt it was suitable for young adults in Norway with MS.

(3) *User Control and Freedom* – The application does not support *undo* and *redo* functions, so the experts suggested it to be implemented.

(4) *Consistency and Standard* – According to the experts, the consistency in the application and use of other universal standards were high and would not cause confusion with users.

(5) *Error Prevention* – There should not be an option for the user to experience error-prone conditions. The expert felt the error messages could be improved since there was currently no error message if the user added empty information to the database.

(6) *Recognition Rather Than Recall* – The experts felt most information was provided in a way that the user did not have to memorize it. E3 pointed out that the linking of known symptoms on the page for writing down symptoms was a nice touch.

(7) *Flexibility and Efficiency of Use* – Experts agreed that the application was suitable for both experienced and inexperienced users.

(8) *Aesthetic and Minimalist Design* – The design of the application was experienced as clean and modern but could be further upgraded in the future.

(9) *Help Users Recognize, Diagnose and Recover from Errors* – The places with an error message were expressed in a plain and precise language, but as mentioned in the fifth heuristic, there was no feedback provided when the user tried to store empty information.

(10) *Help and Documentation* – There was no documentation provided with the application, so after discussing with the experts they gave the heuristic the score 5. They did not see the need for documentation in the future and expressed the application should be intuitive and with that be self-evident.

Chapter 9

Discussion

This chapter discusses methodologies and methods used, the design and development and limitations. The research questions are also answered here.

9.1 Methodologies and Methods

9.1.1 Design Science Research

The design science research methodology was used during the whole research project. During the development of the application YmsE, eight questions (Table 1) were used to ensure all key aspects were covered. The questions were answered in relation to the cycle of the design science research they belong to.

1. *What is the research question (design requirements)?*

Both research questions (Section 1.1) and requirements (Section 5.4) were established early on, which made it easy to know how to design solutions during iterations and move from one cycle to the next. Questions were formulated so that they are relevant to the intended user target group. Solutions were novice and had the potential to make the life of a person with MS better.

2. *What is the artifact? How is the artifact represented?*

The second question is a part of the design cycle with the goal of building and designing. The artifact is a high-fidelity prototype of an application with the name YmsE (Chapter 7), which was designed respecting design principles (Section 4.3) and meeting on user needs. The features also include medical knowledge and activities promoting a healthier lifestyle.

3. *What design processes were used to build the artifact?*

This question is also a part of the design cycle and for this project, there were several design processes explored. The user-centered design (Section 4.2) was in focus, but interaction design principles (Section 6.4.4) and Nielsen's heuristic (Section 6.7.3) were also utilized in the build of an artifact.

4. *How are the artifact and the design processes grounded by the knowledge base? What, if any, theories support the artifact design and the design process?*

A literature review (Chapter 3) was conducted, and both experts and users were interviewed to gather requirements and information, throughout the process they evaluated the artifact during each design iteration (Chapter 8).

5. *What evaluations are performed during the internal design cycles? What design improvements are identified during each design cycle?*

During the internal design cycle, there was a focus on rapidly iterating feedback and continuing evaluating before reaching the satisfactory design solution. For this purpose, several methods were used, such as SUS (Section 6.4.5 and Section 6.6.3), usability testing (Section 6.5.3) and Nielsen's heuristics (Section 6.7.3). Improvements are identified in both Chapter 6 and Chapter 8.

6. *How is the artifact introduced into the application environment and how is it field tested? What metrics are used to demonstrate artifact utility and improvement over previous artifacts?*

This question is a part of the relevance cycle and information that lead to improvements was largely gathered from case studies (Section 6.5.2), usability testing (Section 6.5.3), and interviews (Section 6.3.4 and Section 6.7.2). Changes were also implemented with the user guiding e.g. placement of menu and other design choices. The metrics were method specific, for example, SUS is returning a score as a number and grade. The heuristics by Nielsen's was calculated as a score ranging from 1 to 10. Time of task completion in usability testing was expressed in seconds.

7. *What new knowledge is added to the knowledge base and in what form (e.g., peer-reviewed literature, meta-artifacts, new theory, new method)?*

To add new knowledge when following design research science, is a part of the rigor cycle. An artifact called YmsE is implemented as a high-fidelity prototype (Chapter 7). There is also a master thesis documenting the research and a publication that will be indexed in the PubMed database (Appendix D).

8. *Has the research question been satisfactorily addressed?*

The last question from the checklist is a part of the relevance cycle and all the research questions are answered at the end of this chapter (Section 9.4). The answers are presenting some details and cross-references from chapters in the thesis, which give complete information.

9.1.2 User-Centered Design

The User-Centered Design (UCD) process was a good approach for this application since it relies on the feedback from the intended users (i.e. young adults with MS). An application needs constant improvements, which is achieved by iterating the design through several phases. UCD has a focus on satisfying user needs and preferences. The four phases (Figure 4) were implemented in the design process within the project.

9.1.2.1 Conceptual Design

The four guidelines from the conceptual design process (Table 2) worked well with the other design principles and methods during this project. All four guidelines were implemented and used frequently, an open mind was needed for not rejecting suggested requirements. The most valuable information was collected from the users and experts and by always iterating and coming with improved versions of the prototype, the users always had new and valuable feedback. The conceptual design model (Figure 20) was also a big help before starting to prototype and reduce unnecessary time spent on understanding what the interaction between the user and application should be.

9.1.2.2 Design Prototyping

Prototyping may be time-consuming, especially high-fidelity prototyping, but the outcome is very rewarding. Users need to interact to know what they are getting and how to improve the design in the future. The low-fidelity versions were quick and easy to change and therefore several versions were tested before spending more time on mid- and high-fidelity prototyping. The feedback from users and experts were much more useful and helpful when displaying prototypes, they could interact with.

9.1.3 Design Principles

The design principles were used to ensure the usability of the application. They focus on design over content and all five principles were implemented to get an intuitive UI (Section 6.4.4). They help to enhance the design of an application and could be recommended for designing an artifact. Based on the experience of this project, the design principles were crucial for securing continuity and systematic development.

9.1.4 Data Gathering

9.1.4.1 Literature Review

In the first design iteration, a literature review (Chapter 3) was conducted to gather data. It was a great method for understanding what sort of theoretical and practical work had been done related to the delivery of information about MS. It became clear that there was a need for more specific information about young adults in Norway, living with MS. The literature review was the foundation of the project.

9.1.4.2 Semi-Structured Interview

Semi-structured interviews (Section 6.3.4 and Section 6.7.2) were used in the project to gather qualitative data. The method worked very well and by having them only semi-structured, the information in the room could flow naturally and if the discussion stopped, the pre-defined questions were asked. A lot of the times while interviewing, the pre-defined questions were already answered by the experts even before being asked. The experts were from different fields connected to MS. The last interview with physiotherapist gave a lot of suggestions on improvement and the future of the application. One challenge with the interviews was to create time for them. The experts are busy people, but supportive, so it would be of great advantage to involve them in future design iterations, as well.

9.1.4.3 Social Media Focus Group

A focus group is valuable for gathering information directly from the intended users, who share the same interest, problems or concerns (Section 6.4.3). Acquiring information from a big group might be imbalanced since some people are shy and easily fall in the background, while those more communicative easier can take control over the discussion to voice their opinions. The environment in the social media focus group feels less pressing, which makes it easy to discuss sensitive information such as challenges living with MS. In addition, some might prefer writing instead of speaking, which give the users time to reflect and formulate themselves at their own pace.

9.1.4.4 Survey

The survey provided a lot of information on design and content in a short amount of time. The survey was conducted in the second design iteration (Section 6.4.3) by the intended users of the application. The feedback was valuable and useful, which lead to important improvements in design choices and what functionalities and content should be included. Surveys usually consist of close-ended questions and allow limited short comments, so at the end of the survey, there was a place dedicated for the users to leave their suggestions and comments.

9.1.4.5 Case Study

The case study conducted with two individuals within the third design iteration (Section 6.5.2). Feedback regarding user preferences, usability and content were discussed in detail. They were observed using the application, which provided an insight on how they maneuvered through the content, what felt intuitive and what perhaps might raise concerns for the future.

9.1.5 Evaluation of Prototypes

9.1.5.1 Usability Testing

From this experience, usability testing gave a good indication of whether the UI was intuitive or not. Users were given seven tasks that they all managed to complete without guidance (Section 8.3), which implies that the interface was easy to understand. To have the intended target group testing the application provides helpful insight. It is also important to observe the users during the usability test as it helps detect issues that might not be noticeable otherwise since they are not expressed in seconds or in terms of task completion.

9.1.5.2 System Usability Scale

SUS is a quick and easy evaluation method suitable for most systems and artifacts. If the project includes a design specific process with a focus on users to develop artifacts, positive SUS results will reflect that. Usability experts performed an evaluation in the second design iteration (Section 6.4.5), whilst users evaluated during the fourth design iterating (Section 6.6.3). Some issues were highlighted with the help of the SUS method (Section 8.2) but it should not be the only form of evaluation during a development project with users. Usability testing would be a useful complement.

9.1.5.3 Nielsen's Heuristics

Usability experts are an excellent source of reassurance and good ideas. They evaluated the application in the fifth design iteration separately before discussing the results in plenum (Section 6.7.3). To have experts evaluate with Nielsen's heuristics did discover aspects of the applications that could have been better thought out and the application could have benefited from an evaluation in an earlier design iteration as well. More experts could have tested it since it is a cheap, intuitive method with no prior planning required. The experts did feel the application would be satisfactory for users, both experienced and inexperienced (Section 8.4).

9.2 Prototype Development

The usage of low-, mid- and high-fidelity prototypes in design iterations were useful for the visualization of functionalities. To have prototypes for users and experts to interact with was crucial when receiving feedback, and the higher the fidelity, the more suggestions were collected. The prototype was designed with the help of ReactJS and deployed with Netlify. The deployment made it possible for evaluators to experience the application on the intended device and therefore gave more concrete comments. The prototype development had in theory only five main design iterations, but there was in fact, a lot of tiny iterations in between the main design iterations, that lead to continuous improvements of the prototype. The smaller design steps or iterations were helpful to monitor progress and achieve usability goals.

9.3 Limitations

The research project did come across some limitations. Most of the limitations were due to the time constraints of the research. To accomplish more design iterations that would truly satisfy users is the goal for the future. To achieve that, users should still be involved in the design process and have a longer evaluation process extended over a longer time period in a natural setting, to truly identify issues about content, design, and interface. More functionalities could also be implemented, but due to the timeframe of the project, they have been transferred into future work.

9.4 Answering Research Questions

The two research questions will now be discussed;

RQ1: *What functionalities needs to be included in an application for young users with MS in Norway, that would help improve lifestyle changes and gain approval from both users and medical staff?*

Data gathered from the intended user group, medical staff, and usability experts have provided an insight into what could be included in an application for young adults in Norway with MS to satisfy their needs.

After talking to both users and medical experts, there is definitely a market potential for an MS application focusing on a healthier lifestyle and quality of life for the target group. By including both users and medical experts in the development process, it was clear that expectations could be transformed into requirements and further implemented into a prototype called YmsE (Chapter 7).

A literature review (Chapter 3) and an analysis of a social media platform for users with MS (Figure 9) helped establish the main concerns which were later converted into functionalities that could help

encourage lifestyle changes. Because of a user-centered design process (Section 4.2), a reassurance of other necessary functionalities was discovered by the users during different design iterations, including a focus group (Section 6.4.3), a case study (Section 6.5.2), usability testing (Section 6.5.3) and evaluation with SUS (Section 8.2). This group of users wanted to have good design, but they also wanted particular information about MS that would help increase life quality and monitoring the disease in a discreet way. The case study has shown that none of the users wanted to be reminded of the disease but rather keep healthy and well informed. Medical staff did also contribute to an understanding of user needs during interviews (Section 6.3.4 and Section 6.7.2). Lastly, usability experts helped improve design and interface by evaluating the application with SUS and applying Nielsen's heuristics. Functionalities that were incorporated consisted of monitoring symptoms, medical information and medication (Section 7.1), exercise and stretching (Section 7.2), overview of common words and phrases (Section 7.3), information regarding symptoms, questions and contact information (Section 7.4) and lastly a gamification aspect for encouragement (Section 7.5).

To receive trust from both medical staff and young adults with MS in Norway, it is essential to have close cooperation between doctors, nurses, physiotherapists and developers in the future. By having an expert from each field, the user can be reassured that they will only receive relevant and verified information.

RQ2: *What is a good proportion of medical information and lifestyle information in an application for people with MS?*

Content with a balance between medical information and lifestyle information is preferred from the intended target group of the application. Newly diagnosed focus more on medical information in the beginning to grasp the magnitude of the disease and everything regarding the MS diagnosis. Medical experts such as physiotherapists emphasize the importance of including correct and helpful medical information regarding the form when performing exercises.

Both participants from the case study have expressed that reminders about the disease once a day was not preferred. The focus group informed that daily reminders vibrating on the phone (e.g. take medication) was reasons for uninstalling previous applications. Neither participants of the case study or the focus group wanted to be reminded or aware of the diagnose if not necessary. More illustrations were mentioned during the case study to not to have an overkill of text since it could be overwhelming for most people and especial newly diagnosed.

After discussing with users, most of them do not want to be reminded about their MS 24/7. The option to use the application for reading about medical information when needed, as long as the questions are

not urgent. Gradually they are interested in knowing about vocabularies (Section 7.3), information regarding treatment, financial aid, interest groups or whom to contact (Section 7.4).

When they are ready to control the disease and strive for a healthier lifestyle, options to read about tips for improving lifestyle choices, tracking symptoms and questions for the next appointment and information about treatment (Section 7.1), workout programs for 5 or 10 minutes, stretching exercises for morning and evening, as well as a program that can be tailored together with a physiotherapist or personal trainer (Section 7.2), and a point system to encourage a healthy lifestyle (Section 7.5) is presented for them through the application.

The conclusion is that there should be a balance, but also that the users can choose what part of the application they want to use, whether it is medical or lifestyle information. Medical staff should remain involved in development for their insight, contribution and updating medical information.

Chapter 10

Conclusion and Future Work

10.1 Conclusion

The Design Science research methodology was applied throughout the research project, to ensure relevance, rigor, quality, and design of an artifact. Based on the user and expert evaluation, the results could be deemed as a novel, meaningful and a contribution to the knowledge base.

The project has contributed with a high-fidelity prototype of an application with the name YmsE. The application is dedicated to supporting a healthy lifestyle for young adults with MS in Norway. During the span of five design iterations, user requirements and feedback were collected throughout the development process. An approval from the Norwegian Centre for Research Data was obtained to ensure the privacy of data. The data was gathered and analyzed based on a literature review and social media platform for people with MS which all helped to establish a core of requirements. Based on those, a conceptual model was designed, to understand the interaction between the user and the application. The application was built by prototyping, starting with a low-fidelity prototype drawn on paper, to a high-fidelity prototype fully interactive and therefore tested by the intended users and experts. There were several iterations of evaluations and refinement. YmsE was developed with the framework ReactJS and deployed with Netlify.

The project used User-Centered Design, as a method to provide an artifact that would be appreciated by the intended user group. The process followed four phases, in which user involvement was strong and continuous. There was a focus group organized with the help of social media, to discuss progress and understand needs. Based on the feedback from the group a mid-fidelity prototype was developed and later, the design principles were implemented, to create an intuitive interface. A case study with two participants was conducted. They were both observed while interacting with the application to detect usability issues. The participants from the case study also conducted usability testing performing seven tasks, which returned a high success rate. The same goes for the system usability scale, where users gave a high usability score which was compared to the grade “A” on the SUS scale.

Usability experts performed a SUS evaluation before the users, to ensure good quality before involving the intended users in testing. The SUS score graded “C” suggested there was still room for improvements. The usability experts also reviewed Nielsen’s heuristics to establish how intuitive the user interface was.

Medical experts from Haukeland University Hospital provided insight into user needs from their point of view and suggested what medical information regarding MS could be implemented into the application.

It has become clear that persons with MS are not patients 24/7. On the contrary, they can be self-efficient, regarding physical activity and keep an eye on their condition and make healthy lifestyle choices. The application YmsE, therefore, provides guidance for maintaining a good quality of life and combine it with essential medical information.

10.2 Future Work

10.2.1 Maintaining YmsE

For an application to survive and serve a purpose, maintaining the application is vital. The high-fidelity prototype YmsE is an application containing medical information which should be updated when new relevant information is being published and scientifically discovered. The application should also be created in collaboration with a company working with mHealth or organizations such as Helse Vest IKT. To make the information visible to potential users the application should be available in the Google Play store or iTunes. The best-case scenario is to let developers implement the functionalities and design useful illustrations to create a *positive vibe* avoiding too much text.

10.2.2 New Features

New features for the application have been mentioned in several chapters. New features and enhancements of existing functionalities are always appreciated. The focus and case study groups suggested implementing some functionality with healthy recipes easy to make, to spare energy. Some recipes could be displayed, and the user could later add on if necessary. If the application took a turn towards a community platform for people with MS, the options to share recipes should be considered.

A method regarding visual impairment could be implemented. The user could have the option to choose between two different styles, where one is customized for those who have problems with their vision (e.g. scaling up the text or have contrasting colors).

It would be preferable if changes from diets, supplement, physical activity, and symptoms would be registered to see if it would have positive improvements. Doctors and researchers would appreciate data from the users that they are not collecting during visits which could be beneficial to understand a wider

picture of persons with MS. In a future design iteration, it could be a functionality dedicated to tracking mood, sleep, and fatigue, by using a color system. Such information could later be shared with medical staff to find a correlation. Another feature that could benefit from a collaboration with medical staff is a way to ask “embarrassing” questions anonymously.

In the future, a better connection with human-computer interaction would be appreciated. For example, a user could track information that a smartphone already tracks, such as the number of steps and the pulse. The application could also alert the user to move more if they are sitting too much.

It would also be appreciated to further implement a gamification aspect where the users could get points regarding lifestyle choices, either positive or negative. If the community platform would be implemented, creating challenges for the users to move or work out more. Since MS can affect memory, a cognitive game could be implemented to help memorize things. There is always room for improvements and therefore no limit for further implementations.

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Appendix A

A 1 - Approval from NSD

NSD NORSK SENTER FOR FORSKNINGSDATA

NSD sin vurdering

Prosjekttittel

En livsstil app for unge voksne med MS

Referansenummer

167807

Registrert

19.09.2018 av Martine Oppegaard Jakobsen - Martine.Jakobsen@student.uib.no

Behandlingsansvarlig institusjon

Universitetet i Bergen / Det samfunnsvitenskapelige fakultet / Institutt for informasjons- og medievitenskap

Prosjektansvarlig

Ankica Babic, ankica.babic@uib.no, tlf: 55589139

Type prosjekt

Studentprosjekt, masterstudium

Student

Martine Oppegaard Jakobsen, martine.o.j@gmail.com, tlf: 97136438

Prosjektperiode

15.10.2018 - 07.06.2019

Status

29.10.2018 - Vurdert

Vurdering (1)

29.10.2018 - Vurdert

Det er vår vurdering at behandlingen vil være i samsvar med personvernlovgivningen, så fremt den gjennomføres i tråd med det som er dokumentert i meldeskjemaet 29.10.2018 med vedlegg. Behandlingen kan starte.

MELD ENDRINGER

Dersom behandlingen av personopplysninger endrer seg, kan det være nødvendig å melde dette til NSD ved å oppdatere meldeskjemaet. På våre nettsider informerer vi om hvilke endringer som må meldes. Vent på svar før endringen gjennomføres.

TYPE OPPLYSNINGER OG VARIGHET

Prosjektet vil behandle særlige kategorier av personopplysninger frem til 7.6.2019.

LOVLIG GRUNNLAG

Prosjektet vil innhente samtykke fra de registrerte til behandlingen av personopplysninger. Vår vurdering er at prosjektet legger opp til et samtykke i samsvar med kravene i art. 4 nr. 11 og art. 7, ved at det er en frivillig, spesifikk, informert og utvetydig bekreftelse, som kan dokumenteres, og som den registrerte kan trekke tilbake.

Lovlig grunnlag for behandlingen vil dermed være den registrertes uttrykkelige samtykke, jf. personvernforordningen art. 6 nr. 1 a), jf. art. 9 nr. 2 bokstav a, jf. personopplysningsloven § 10, jf. § 9 (2).

PERSONVERNPRINSIPPER

NSD finner at den planlagte behandlingen av personopplysninger vil følge prinsippene i personvernforordningen:

- om lovlighet, rettferdighet og åpenhet (art. 5.1 a), ved at de registrerte får tilfredsstillende informasjon om og samtykker til behandlingen
- formålsbegrensning (art. 5.1 b), ved at personopplysninger samles inn for spesifikke, uttrykkelig angitte og berettigede formål, og ikke viderebehandles til nye uforenlige formål
- dataminimering (art. 5.1 c), ved at det kun behandles opplysninger som er adekvate, relevante og nødvendige for formålet med prosjektet
- lagringsbegrensning (art. 5.1 e), ved at personopplysningene ikke lagres lenger enn nødvendig for å oppfylle formålet

DE REGISTRERTES RETTIGHETER

Så lenge de registrerte kan identifiseres i datamaterialet vil de ha følgende rettigheter: åpenhet (art. 12), informasjon (art. 13), innsyn (art. 15), retting (art. 16), sletting (art. 17), begrensning (art. 18), underretning (art. 19), dataportabilitet (art. 20).

NSD vurderer at informasjonen som de registrerte vil motta oppfyller lovens krav til form og innhold, jf. art. 12.1 og art. 13.

Vi minner om at hvis en registrert tar kontakt om sine rettigheter, har behandlingsansvarlig institusjon plikt til å svare innen en måned.

FØLG DIN INSTITUTEJONS RETNINGSLINJER

NSD legger til grunn at behandlingen oppfyller kravene i personvernforordningen om riktighet (art. 5.1 d), integritet og konfidensialitet (art. 5.1 f) og sikkerhet (art. 32)

For å forsikre dere om at kravene oppfylles, må dere følge interne retningslinjer og eventuelt rådføre dere med behandlingsansvarlig institusjon.

OPPFØLGING AV PROSJEKTET

NSD vil følge opp ved planlagt avslutning for å avklare om behandlingen av personopplysningene er avsluttet.

Lykke til med prosjektet!

Kontaktperson hos NSD: Lasse André Raa

Tlf. personverntjenester: 55 58 21 17 (tast 1)

Appendix B

B 1 - Informed Consent Form

Forespørsel om deltagelse i forskningsprosjektet

A smartphone app promoting lifestyle changes in young adults with MS

Dette er et spørsmål til deg om å delta i et forskningsprosjekt hvor formålet er å se om en smarttelefon applikasjon kan hjelpe en person med multiple sklerose å forbedre livsstilen sin. I dette skrivet gir vi deg informasjon om målene for prosjektet og hva deltagelse vil innebære for deg.

Bakgrunn og formål Dette forskningsprosjektet er en del av en masteroppgave ved instituttet for informasjons- og medievitenskap ved Universitetet i Bergen. Forskningsprosjektet søker unge voksne med MS til å svare på om en applikasjon kan hjelpe til med å forbedre livsstilen til dem med MS. Fokusområdet for prosjektet vil være å samle informasjon om tidlig oppfatning av sykdommen, støtte man har mottatt fra sykehus, hvordan den kan forbedres og hvordan egen helse kan forbedres ved hjelp av en applikasjon.

For å kunne bidra med å skape en hjelpsom og nyttig applikasjon, vil leger, sykepleiere, fysioterapeuter, ernæringsfysiologer og andre aktuelle fagpersoner bli intervjuet angående det faglige. De har blitt valgt basert på deres stilling samt anbefalinger fra eget nettverk.

Hva innebærer deltagelse i studien? Ved å delta i studien, vil man hjelpe til med å tilpasse en applikasjon etter ens behov. Det vil skje via personlige intervjuer eller spørreundersøkelser på nett. Det vil aldri ta mer enn 1 time. Under alle intervjuer vil det bli tatt skriftlige notater og om nødvendig vil det bli lydopptak, men det vil man få beskjed om på forhånd.

Hva skjer med informasjonen om deg? Alle personopplysninger vil bli behandlet konfidensielt. Det er kun masterstudenten og veilederen for prosjektet som har tilgang til personopplysninger. Personopplysningene lagers ikke direkte med navn, men vil bli anonymisert ved hjelp av et referansenummer. Navneliste med kodenøkkel vil oppbevares separat fra oppgaven og annet materiale, slik at det ikke vil være mulig å identifisere brukerne.

Deltagere i studien vil ikke kunne gjenkjennes i publikasjonen med mindre de selv samtykker at deres navn kan publiseres.

Prosjektet skal etter planen avsluttes 1. juni 2019. Ved prosjektslutt vil alle filer med personopplysninger slettes, med unntak fra dem som samtykker om at deres navn kan presenteres i oppgaven. Navneliste og kodenøkkel vil slettes og alle lydopptak samt førte notater vil bli slettet og makulert.

Frivillig deltagelse Det er frivillig å delta i studien, og du kan når som helst trekke ditt samtykke uten å oppgi noen grunn. Dersom du trekker deg, vil alle opplysninger om deg bli anonymisert. Det vil ikke ha noen negative konsekvenser for deg hvis du ikke vil delta eller ved en senere anledning velger å trekke deg.

Dine rettigheter Så lenge du kan identifiseres i datamaterialet, har du rett til:

- innsyn i hvilke personopplysninger som er registrert om deg,
- å få rettet personopplysninger om deg,
- få slettet personopplysninger om deg,

- få utlevert en kopi av dine personopplysninger (dataportabilitet), og
- å sende klage til personvernombudet eller Datatilsynet om behandlingen av dine personopplysninger.

Hva gir oss rett til å behandle personopplysninger om deg Vi behandler opplysninger om deg basert på ditt samtykke.

Dersom du har noen spørsmål om studien, ta kontakt med:

Masterstudent	Martine Oppegaard Jakobsen	971 36 438	martine.o.j@gmail.com
Veileder	Ankica Babic	555 89 138	ankica.babic@uib.no
Personvernombudet	Norsk senter for forskningsdata	555 82 117	personvernombudet@nsd.no

Studien er meldt til Personvernombudet for forskning, Norsk senter for forskningsdata.

Samtykkeerklæring

Jeg har mottatt og forstått informasjon om prosjektet, og har fått anledning til å stille spørsmål. Jeg samtykker til:

- å delta i intervju.
- at mitt navn kan publiseres i oppgaven.
- at mine opplysninger behandles frem til prosjektet er avsluttet 1. juni.

X

(Signert av prosjektdeltager, dato)

B 2 - Interview Guide for Experts

Intervjueguide for forskningsprosjektet Ekspert brukere

A smartphone app promoting lifestyle changes in young adults with MS

Dette er en intervjueguide for prosjektet som handler om livsstil og MS. Det vil bli lagt fokus på å finne ut hva slags informasjon som blir gitt ut til mennesker med MS og om den er tilstrekkelig nok slik at de kan leve et sunt og bra liv, selv med MS.

Informasjon som kommer ut ifra dette prosjektet vil bli behandlet anonymt, med mindre annet er ønsket. Hvis nødvendig og/eller ønskelig, vil samtalen bli tatt opp.

Dette er kun en simplifisert versjon av hvordan et intervju vil se ut i fremtiden.

Presentasjon om hva som har blitt gjort (ca 5 min) En kort presentasjon om hva som har blitt gjort siden sist. Fremvisning av prototyper og ideer.

Spørsmål om MS (ca 25 min) Spørsmål som ønskes å utdypes videre. Spørsmål om ønsker man har fra en mobil applikasjon for dem med MS. Spørsmål som de med MS ønsker svar på.

Diskusjon om hva som kan gjøres videre (ca 25 min) Spørsmål angende hva slags aktivitetsnivå som er ønsket, hvordan gi bedre informasjon til de med MS, hva slags mat og kosttilskudd som er positivt, vaner og ting de med MS burde holde seg unna. Annen informasjon for å forbedre applikasjonen.

Spørsmål som vil bli spurt om og utdypet

Hva er din rolle:

Hvor ofte er du i kontakt med pasienter:

Forventninger du har til et system:

Tror du en app kan hjelpe til med å gjøre jobben din lettere:

B 3 - Interview Guide for Users

Intervjueguide for forskningsprosjektet Unge voksne med MS

A smartphone app promoting lifestyle changes in young adults with MS

Dette er en intervjueguide for prosjektet som handler om livsstil og MS. Det vil bli lagt fokus på å finne ut hva slags informasjon som blir gitt ut til mennesker med MS og om den er tilstrekkelig nok slik at de kan leve et sunt og bra liv, selv med MS.

Informasjon som kommer ut ifra dette prosjektet vil bli behandlet anonymt, med mindre annet er ønsket. Hvis nødvendig og/eller ønskelig, vil samtalen bli tatt opp.

Dette er kun en simplifisert versjon av hvordan et intervju vil se ut i fremtiden.

Spørsmål angående personopplysninger (ca 10 min) Det vil være spørsmål om alder, hvor man er fra, når man ble diagnosert, hvilket sykehus man tilhører, hvilken versjon av MS man har og eventuelle handikap som har kommet på grunn av sykdommen, om man er student og/eller om man har en jobb.

Spørsmål om livsstil (ca 20 min) Spørsmål angende aktivitetsnivå, matvaner, uvaner, kosttilskudd.

Diskusjon om teknologi og applikasjons ønsker (ca 20 min) Spørsmål som ønskes å utdypes videre. Spørsmål om ønsker man har fra en mobil applikasjon for dem med MS.

Del 1

Når ble du født:

Hvor bor du:

Hvilken type MS har du:

Hvordan har MS påvirket deg fysisk:

Har du fått noe for av handikap på grunn av MS:

Hvor gammel var du da du fikk diagnosen:

Hvilket sykehus fikk du diagnosen på:

Hvilket sykehus tilhører du nå:

Hva følte du om informasjon du fikk da du fikk MS:

Hva vet du nå som du ønsker du visste da:

Er du student:

Har du jobb:

Del 2

Hvor mange dager i uken er du aktiv:

Trener du på en spesiell måte:

Hva slags informasjon om trening har du fått og hvem fikk du vite det av:

Hva vet du nå om trening som du skulle ønske du fikk vite om tidligere:

Hvordan vil du beskrive matvanene dine:

Hva slags informasjon har du fått om mat:

Tar du kosttilskudd:

Hva slags tar du og hvem fikk du beskjed om å ta det av:

Røyker du/ hvor mange ganger i uken:

Snuser du/ hvor mange ganger i uken:

Drikker du/ hvor mange ganger i uken:

Del 3

Bruker du apper:

Kunne du brukt en app som er lagd for dem med MS:

Ville du brukt appen til å finne informasjon om

- Trening
- Mat
- Kosttilskudd
- Vann
- Kalender
- Aktivitetsnivå (skritteller)
- Notater
- Skrive ned symptomer
- Chattegruppe
- Ofte stilte spørsmål om MS

Hva ønsker du ut fra en app for dem med MS:

Appendix C

C 1 - System Usability Scale Form

Participant ID: _____ Site: _____ Date: ___/___/___

System Usability Scale

Instructions: For each of the following statements, mark one box that best describes your reactions to the app *today*.

	Strongly Disagree				Strongly Agree
1. I think that I would like to use the app frequently					
2. I found the app unnecessarily complex					
3. I thought the app was easy to use					
4. I think that I would need assistance to be able to use the app					
5. I found the various functions on the app well integrated					
6. I thought there was too much inconsistency on the app					
7. I would imagine that most people would learn to use the app very quickly					
8. I found the app very cumbersome/awkward to use					
9. I felt very confident using the app					
10. I needed to learn a lot of things before I could start the app					

Please provide more comments about the app:

Appendix D

D 1 - Related Publications

Full paper –

17 International Conference on Informatics, Management and Technology in Healthcare

Conference date and location: 5-7 July 2019 Athens, Greece.

A full paper was accepted and will be indexed in PubMed.

Lifestyle Intervention for Young Adults with MS: A Design Study

Martine Oppegaard JAKOBSEN ^{a,1} and Ankica BABIC ^{a, b}

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^b*Department of Biomedical Engineering, Linköping University, Sweden*

Abstract. This paper presents a mid-fidelity prototype of a mobile application for self-management of the chronic disease Multiple Sclerosis (MS). The study focuses on newly diagnosed young Norwegians with MS and wants to deliver IT solutions for a healthier lifestyle. An analysis of a social media platform, interview with medical staff, a social media focus group interview and one case study were utilized to gather data alongside with design iterations. A high-fidelity prototype is being implemented with main functionalities: health, training, patient notes for next medical appointment, disease related life and work issues, and a reward point system.

Keywords. Multiple Sclerosis (MS), young adults, self-management, application.

1. Introduction

Multiple Sclerosis (MS) is a chronic disease that attacks the central nervous system. It can occur at any age, and at the early stages, it is common to have occasional attacks. A minority of patients will see a worsening of the disease after a few years [1]. There is no disease specific test, meaning MS can be hard to diagnose [2]. Medical attention mainly goes to those who suffered with MS for a longer time which in turn often leaves newly diagnosed with less attention and fewer follows-ups during asymptomatic periods. When creating a lifestyle application for young adults one should use technologies to promote wellbeing, connect people and guide them to best available help [3]. Another important issue is to assess the effectiveness of the intervention with measurable means [4]. The aim of this study is to design a prototype with highly relevant content for young adults with MS. Effectiveness could be realised through rewarding good lifestyle choices and collecting data for users' self-management and possibly for sharing with medical staff.

2. Method

The content analysis was carried out for a MS social media platform and thereafter the resulting data was evaluated by experts at the Norwegian Multiple Sclerosis Competence Centre at Haukeland University Hospital. A focus group with five young adults between 20-30 years of age was interviewed. Consequently, a mid-fidelity prototype was designed using the acquired data and evaluated in a case study with two participants.

¹ Corresponding Author. Martine Oppegaard Jakobsen (martine.o.j@gmail.com)

3. Results

3.1 Social Media Analyses

Displayed in Figure 1a-c are some of the data categories regarding the concerns and frequently asked questions at the MS social media platform [5] by the users during the last four years. Proving information are sought out at more places than the doctor's office. The results from the analysis were used to help establish user requirements.

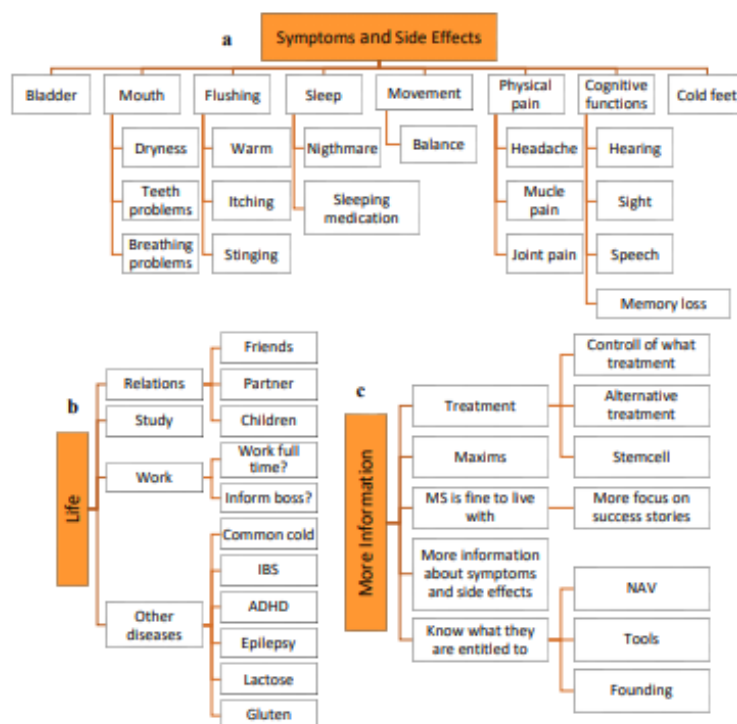


Figure 1a, b and c. Frequently asked questions concerning the MS diagnosis.

3.2 Expert Evaluation

The medical expert evaluation looked at the categories from the Figure 1, as well as some other figures not presented in this paper. After the evaluation, some categories were excluded from the requirements that were not specific for this group (e.g. food functions).

3.3 Interview with Social Media Focus Group

The focus group had a clear and mostly uniform opinion regarding their design and content preferences. All of them had struggled to find a Norwegian app for handling MS.

They did use apps with dark backgrounds such as Spotify, but they did not spend much time scrolling on it and agreed that a light background with dark text and a dash of colour was the best option. The group was presented with a list of functions (*calendar, work out, notes, health, frequently asked questions*) resulting from the analysis of the social media platform and expert evaluation. They wished for a list of available MS-nurses per geographic location. They suggested there should be a place with information on MS for family, friends, and work colleagues, especially bosses. They seek more information about treatment including medicine. One in the focus group would appreciate a caloric counter alongside with healthy recipes. A few would like to have a forum to discuss MS. The majority have found the calendar function redundant. All these results concerning design choices and content were used in the next design iteration.

3.4 Case Study

There were two participants in the case study who evaluated separately. Firstly, there was a 26-year-old female, finishing a master's degree, diagnosed in 2016. The second was a 29-year-old male, with a master's degree, working full time; his diagnosis was established in 2018.

Both liked the colour orange for the applications since it is the MS colour. The font size was good, but the font family was not satisfactory. One meant that there could never be enough content, whilst the other meant too much information could make it hard to navigate through. Suggested improvements were to change the position of the menu and adding a MS-dictionary. In addition, shorter workouts where requested. Information on the medical exams could be compressed when appropriate (e.g. "read more"-button). One felt food recipes were unnecessary whilst the other wanted easy and quick recipes due to fatigue. They both disliked push notifications. Figure 2 displays the landing page and not additional content; the first version of the prototype was created based on the focus group findings, and the second version was implemented after the case study.



Figure 2. The entry menu and the landing page before and after the case study.

4. Discussion

To really understand the needs of young adults, we have joined a Norwegian social media group for people with MS. In direct contacts we have identified main concerns and needs from which a dynamic picture appeared (Figure 1a-c). Important life and quality of life related questions that were discussed. Information often exchanged amongst peers is usually not addressed during regular medical visits, hence the information needs.

The medical experts from Haukeland University Hospital have also appreciated the data coming from this research (Figure 1a-c). Based on such positive feedback, we have designed a prototype to suit young adults and keep them interested in a healthy lifestyle instead of reminding them on the worrisome side of the MS. There are situations such as acute attacks that are demanding on patients and surroundings, but all other times the quality of life remains good. Ideally, they could manage their lives on their own and contact medical professionals when absolutely needed. An app would thus be helpful.

We have also used a case study to gain more information about the conditions of living with MS and to evaluate the prototype. The detailed feedback provided some reassurance that this kind of lifestyle tool would be a good addition to the already existing information [6]. Evaluation by the IT experts and the social media group will be important for refinement of the current design solutions.

5. Conclusion

The design for young adults with MS is the first in Norway, tested by a mini social media focus group and participants of a case study. Their suggestions have influenced the content and design. The results were satisfying but could be further improved regarding the medication, an MS dictionary, information on the medical exams, as well as suggestions for short, straightforward physical exercise and easy to make recipes. All these should help young adults with MS to maintain a conscious and healthy lifestyle.

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