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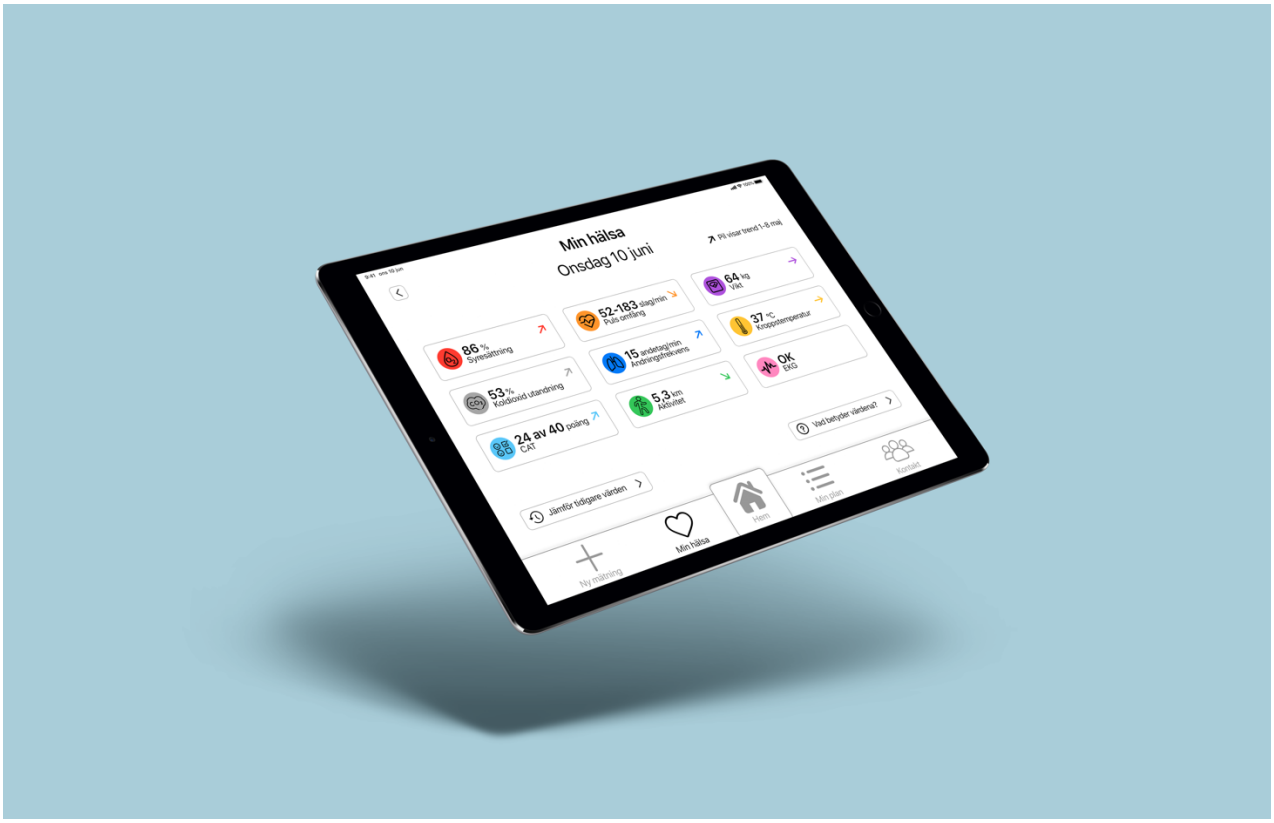

User Experience Design of a Virtual Hospital

Increasing self-care through measurement and visualization of medical data

Master's thesis in Industrial Design Engineering

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Abstract

For people living with chronic diseases; hospital visits and treatment plans are a part of everyday life. At the same time, Swedish healthcare struggles with limited resources and an aging population. To deal with these issues, Region Halland is developing the Virtual Hospital, a digital healthcare system. The system allows patients to measure vital parameters with their own equipment at home, and the data is synchronized to the regional database. This enables hospitals and healthcare centers to access the data so that they can monitor the patients remotely and make more precise assessments.

In this thesis, the possibilities of making the Virtual Hospital accessible for patients was explored. A stakeholder analysis workshop with different professions connected to the Virtual Hospital project was made, to investigate who is involved in the system and how they can benefit from it. Patients with Chronic obstructive pulmonary disease (COPD) were selected as the target group, and their treatment process was investigated by interviewing COPD nurses.

Based on this, an interface for the Virtual Hospital aimed at patients was developed. The parts of the treatment process that were found suitable to perform by the patient themselves were implemented as functions in the interface. User experience design guidelines for the target group and design principles for consumer applications were used to make the interface understandable and recognizable. A clickable wireframe version of the interface was created and tested in a small user test, to evaluate the design and navigation.

The interface created in this project is designed to be the link between the patient and the hospital. It guides the patient through the routine of measuring vital parameters and filling out forms for COPD Assessment Tests (CAT), and the data and trends can be easily overviewed. The patient can also access their rehabilitation plan and get reminders for medication and exercise. If questions arise, medical professionals can be easily contacted for health advice and follow ups. The hope is that the Virtual Hospital will make the patients more independent and give them a higher quality of life.

This is only the first step in the development of an application for the Virtual Hospital, but the project has shown that the possibilities of involving the patient in the digital healthcare system are great. There seems to be a demand for increased self-care, and the patients and medical professionals involved in the project have shown a high interest in the technology. Therefore, the Virtual Hospital application should be subject to further development.

Acknowledgements

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Medical technology is a fascinating area where new innovations can improve people's lives, and for two engineering students, exploring this topic has been very interesting. The project would not have been possible without the input from the medical professionals, so we would like to thank everyone that has given us some of their valuable time this spring. Thank you to everyone at Hälsoteknikcentrum for the thorough introduction to the Virtual Hospital project and the input along the way. The knowledge and insights that you have provided have been of great value. A special thank you to Elin Jonsson at Hälsoteknikcentrum for the support and the encouragement. In addition, we would like to thank Jacob Gunnarsson for the feedback and experience.

Lastly, we would like to say a big thank you to our supervisor and examiner at Chalmers University of Technology, Cecilia Berlin, for the support throughout the project. The ideas we have discussed have added a holistic perspective and taken the project in new interesting directions.

Gothenburg, June 16th, 2020

Olof Henning and Christopher Thörn

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Glossary

English	Swedish	Definition
Digital healthcare	E-hälsa	Digital technologies aimed at increasing healthcare efficiency and personalizing medicine
Self-care	Egenvård	Taking care of oneself when ill or performing simpler medical tasks
Home care	Hemsjukvård	Healthcare provided in the patient's home
Healthcare recipient/ Patient	Vårdtagare/Patient	Participates in the health care system to receive therapeutic, diagnostic, or preventive procedures
Health promotion	Friskvård	Activities that prevent future diseases
Home care services	Hemtjänst	Social service that helps people in their homes
Continuity of patient care	Vårdkedja	Healthcare provided from the initial contact, following the patient through all phases of medical care
Physical therapist	Fysioterapeut/Sjukgymnast	Prevents, corrects, and alleviates movement dysfunction
Occupational Therapist	Arbetsterapeut	Helps patients develop or regain skills needed to achieve independence in their lives
Nutritionist	Nutritionist/Dietist	Gives dietary advice
Multimorbidity	Multisjuklighet	The complex interactions of several co-existing diseases
Licensed practical nurse	Undersköterska	Does not hold professional degrees or credentials, but is licensed to provide routine patient care under the direction of registered nurses
Business developer	Verksamhetsutvecklare	Improves work procedures, methods and processes in an organization
Head of unit	Enhetschef	Responsible for a healthcare facility
Specialist Reception	Specialistmottagning	Facility for specialized healthcare as result of referral from primary care
Dyspnea	Andnöd	Difficult or labored breathing
Oximetry	Syrgasmätning	Determination of oxygen-hemoglobin saturation in the blood
Capnograph	Kapnografi	Continuous recording of carbon dioxide of expired air

1

INTRODUCTION

1 Introduction

1.1 Background

The healthcare sector in Sweden faces great challenges with high workloads and increased costs. At the same time, the digitalization of society creates expectations on increased quality and accessibility, and many healthcare recipients demands individual solutions. On the other hand, this creates opportunities for new technological solutions that can improve the situation for both healthcare recipients and healthcare providers. Remote monitoring of medical data is one area that can increase efficiency by allowing the healthcare provider to detect changes and respond faster. If the data is made accessible for the healthcare recipient, it also has the possibility to make them more engaged in their health and more involved in their treatment process. In addition, the general direction for the Swedish regions and municipalities is that home care has to increase to meet the healthcare needs and remote monitoring is an important part of that development (SALAR, 2019).

One instance working with remote monitoring is Hälsoteknikcentrum Halland (HCH), an innovation arena at Halmstad University where academia, industry and the healthcare sector collaborate. HCH focuses on healthcare, smart homes and the use of AI, and one of their projects is the concept Virtual Hospital. Virtual Hospital is a digital healthcare system that connects healthcare recipients with healthcare providers to facilitate self-care and relieve the healthcare sector. The idea behind the concept Virtual Hospital comes from the fact that Region Halland has a lot of sorted medical data, and since the region consists of only six municipalities this data is relatively easy to overview. The idea is to use this data to connect hospitals, healthcare centers and patients' homes to create seamless transitions between the instances.

Facilitating self-care is important to increase home care (Bal Özkaptan & Kapacu, 2016). Self-care can be described as when a patient can take care of him/herself to prevent illness and that otherwise would require healthcare personnel. It requires that a licensed healthcare professional beforehand has given direction and assessed that a patient is able to do self-care. An example of self-care is prescription medicine that the patient follows accordingly. There is a tremendous potential in expanding self-care with the help of today's technology development. It can benefit healthcare personnel to ease workload, give the right treatment in an efficient way, and improve assessments with better premises. The previously conducted work at HCH indicates that many medical professionals would like this area to increase, since it can improve the quality of the healthcare and shorten healthcare waiting lists. To facilitate self-care and to make the healthcare recipient more engaged in their treatment process is also an important goal of the Virtual Hospital, and therefore it will be the focus of this project.

At the initiation of this Thesis Work, the project Virtual Hospital is at a stage where a working prototype can measure several types of vital parameters (capnography, respiratory rate, heart rate and oxygen saturation) and send this data to the database for Region Halland. This measurement system is installed in a research environment that is built like a normal 40 m2 apartment, called Halmstad Intelligent Home (HINT). In HINT, a large screen of the brand FlatFrog and an Android tablet are available for displaying data, and the measured data can be displayed in an interface that is normally used by medical professionals. This interface only shows figures and graphs, and there is a need for an interface that can be used and understood by the healthcare recipient themselves. Previously conducted work has been done at HCH targeting patients with chronic diseases. Since this project is a continuation of what has previously been done, this thesis will also focus on this type of patients. A significant part of the population suffers from one or more chronic diseases, and it is consequently a good starting point for developing a digital healthcare system.

1.2 Aim

The aim of the project is to develop a user interface that visualizes medical data in a way that is comprehensible and trustworthy for both healthcare recipients and healthcare providers. The intention is to facilitate self-care and make the healthcare recipient more engaged in their treatment process. The interface should also demonstrate the vision of the Virtual Hospital and its benefits for healthcare providers.

1.3 Research Questions

I. How can the Virtual Hospital enable home care and facilitate self-care for healthcare recipients?

II. How can the Virtual Hospital assist healthcare providers and what information do they wish to communicate through the interface?

1.4 Demarcations

- The interface and the stakeholder map in this project may be used for various medical applications. However, the primary focus in this project will be COPD.
- The Explore phase will determine which stakeholders are relevant in the treatment process of COPD, and only these stakeholders will be considered in the Create phase.
- The focus will be a digital user interface for a tablet. Thus, hardware and data processing of the prototype will not be considered.
- The research measurement architecture will be based on (HINT) Halmstad Intelligent Home and will not represent all types of facilities and living conditions.
- The final concept will be defined in illustration or clickable mock-up. However, the technical details i.e. computer programming will not be considered.
- The current legislation in the healthcare sector will not be considered since the ambition is to demonstrate the benefits of future implementations with the Virtual Hospital concept.

1.5 Process

The project was divided into five major phases, see **figure 1.1**. In the first phase the state of the art was reviewed, including technology and stakeholders connected to digital healthcare. The case for this project, creating a user interface for patients with COPD, was also investigated further with a benchmark of relevant consumer applications and a brief review of the consequences of the disease. This was followed by an iterative Explore phase in which user needs were investigated through interviews, and stakeholders analyzed through a workshop. Based on this, personas were created and requirements for VH and the application were formulated in a phase called Define. This was used to develop an interactive wireframe of the application in the Create phase. Lastly, the final concept was tested and evaluated for further development.

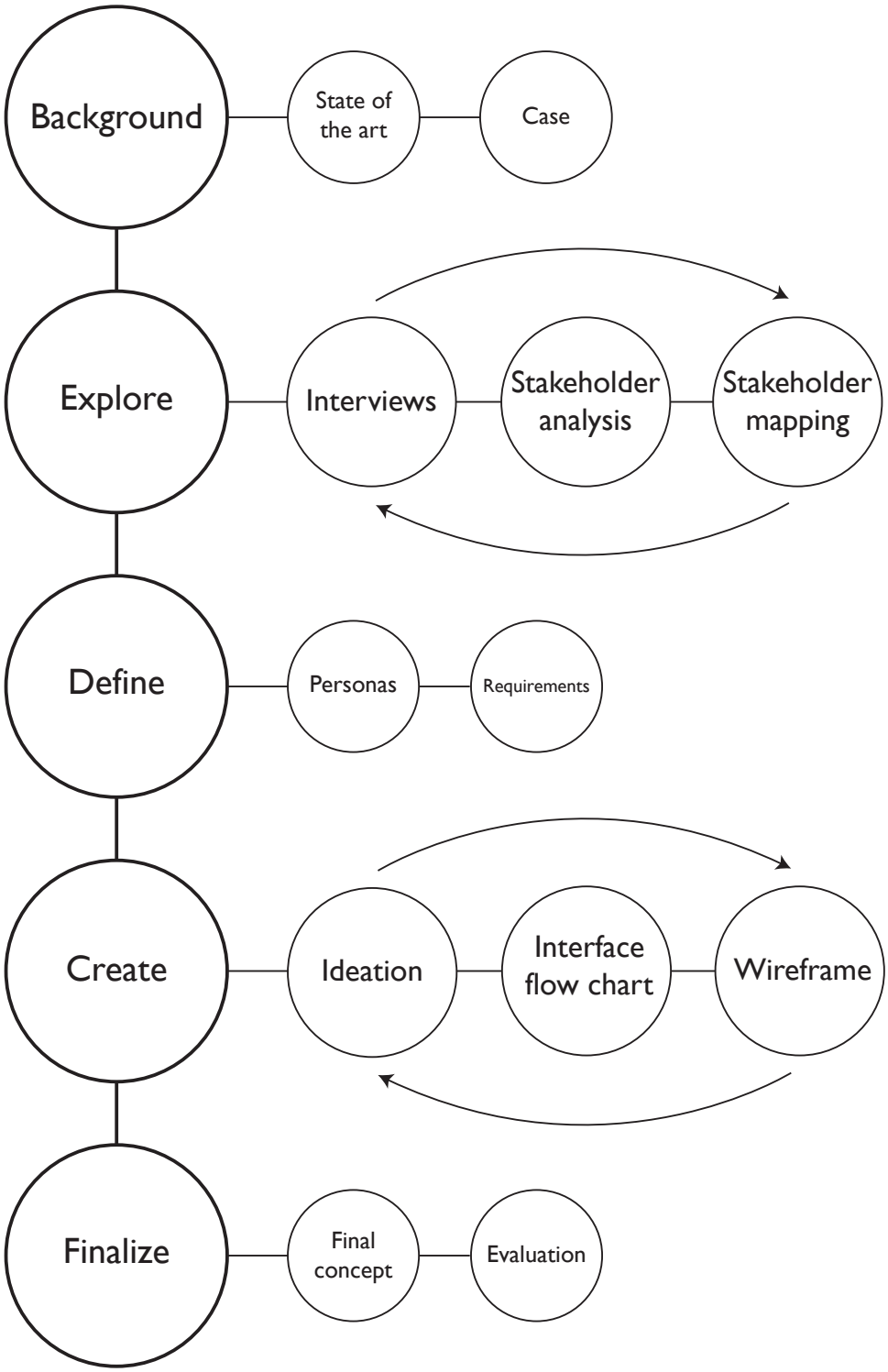


Figure 1.1 - Visualization of the project process

2

STATE OF THE ART

2 State of the art

2.1 Digital Healthcare

Digital healthcare is the wide variety of digital services that are part of the healthcare sector (SALAR, 2019). It consists of everything from digital tools and electronic journal systems used by medical professionals to communication and information services used by patients. One application of digital healthcare where these types of functionalities are combined is monitoring of a patient's health status with a measurement system outside of the medical facility, called remote medical monitoring. According to SALAR (2019), the general direction for the Swedish regions and municipalities is that more healthcare should take place in the patient's home and that remote medical monitoring can facilitate this. Blix & Levay (2018) suggests that technology like this can make it possible for the patient to monitor their own health and gain control over their treatment process, and in that way increase the quality of the healthcare without increasing the number of hospital visits. They also find the effort on digital healthcare especially legitimate in Sweden, since some regions are sparsely populated and have a low number of doctors per square kilometer. In these areas services like remote medical monitoring could increase the accessibility of the healthcare.

2.1.1 Types of digital healthcare

SALAR (2018) describes three types of digital healthcare services with different levels of integration between the healthcare recipient and healthcare provider, called *internal*, *stand-alone* and *integrated*. This is illustrated in **figure 2.1**.

Internal digital healthcare services are only accessed and used by medical professionals. It can be administrative software for journal handling and scheduling, but also advanced tools where AI (Artificial Intelligence) is used for decision support.

Integrated services are used by both patients and healthcare providers and allow information to be exchanged. They can offer the same functionality for the patient as the stand-alone services but are most often prescribed and funded by the healthcare provider. The service can either be directly connected to healthcare provider's information system or accessible thorough an interface. The service that is in focus in this project, the Virtual Hospital, is an integrated digital healthcare service, where data will be transmitted between patients and healthcare providers.

Stand-alone services are used by patients but are not connected to the healthcare provider. This can be services for self-care that let e.g. patients with chronic diseases follow a treatment program and get health advice.

Consumer apps can be used by both patients and healthy individuals, but they focus on fitness, health promotion and lifestyle improvement. Examples of this are Lifesum, Runkeeper and Apple Health.

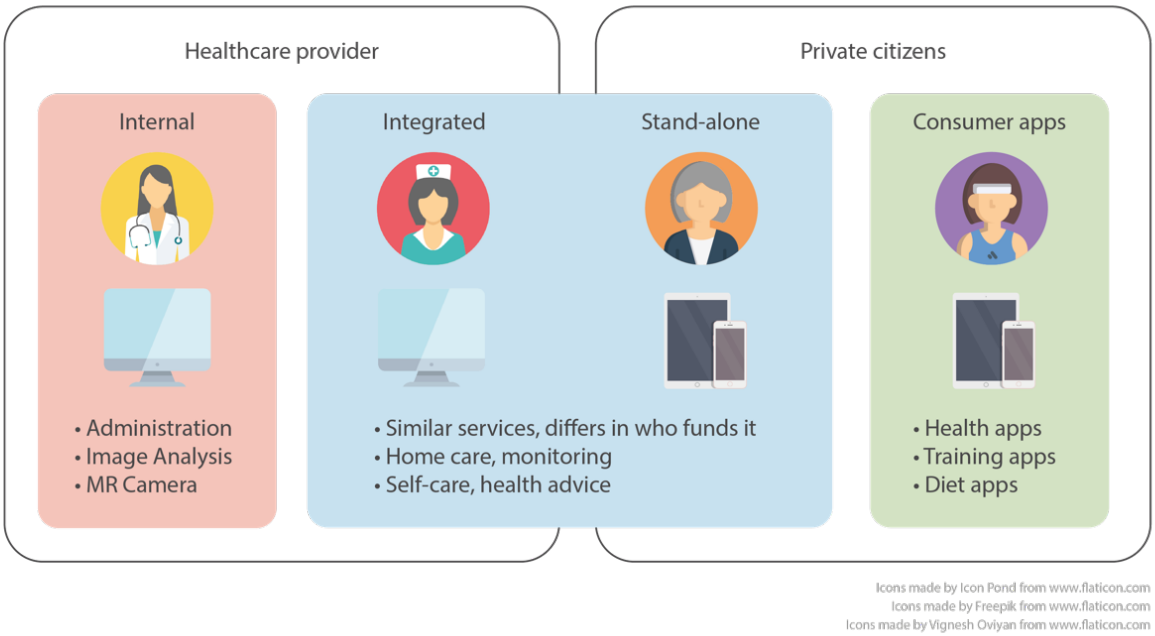


Figure 2.1 - Different types of digital healthcare services. In this thesis integrated services are in focus.

2.1.2 Opportunities with Integrated Digital Healthcare

Digital healthcare services can be used to improve healthcare in many ways, but some major opportunities can be identified, the first being patient engagement. With increasing costs in the healthcare sector due to unhealthy lifestyles and an increasing group of elderly, digitalization is seen as a way to meet these needs by making the citizens more engaged and taking more responsibility for their health (SALAR, 2018). On the subject of engaging the patient in their health, Blix & Levay (2018) state that in the past the patients were limited to the assessment of the responsible doctor, but that they now can access expertise online. Increased knowledge can lead to increased engagement and responsibility, but this type of involvement is relatively new and sometimes controversial. According to Blix & Levay (2018), there are however some patients with chronic diseases that have better knowledge about their treatment needs than some healthcare professionals, and in those cases it can be positive.

As mentioned above, another area where digital healthcare can be of use is Sweden's sparsely populated regions. Here transportation of both patients and staff is a large cost, and if some of these visits can be replaced by digital exchange of information money can be saved.

At last there is the need for co-ordinations between the different healthcare providers. The system is complex with public healthcare providers on both regional and municipal level operating alongside private actors with a wide variety of patients and needs. According to SALAR (2019) problems can appear when a patient gradually needs increased care from more actors. They state that there is a great need for co-ordination and a common infrastructure and suggest that integrated digital healthcare services can facilitate this.

A lot of digital innovations directed towards the healthcare sector are being discussed and while some areas gains a lot of interest but are far from realizable, other areas are starting to become accepted and implemented. A Gartner Hype Cycle (Gartner, 2020) can illustrate this and Schildt et al. (2018) present one for healthcare thechnology, see **figure 2.2**. The authors place remote medical monitoring in the phase called "Slope of enlightenment", meaning that the technology is getting more mature and that innovative organizations have the possibility to take the step and develop and implement it. This indicates that this type of technology is a suitable focus area when investigating the benefits of digital healthcare and when developing new products for it.

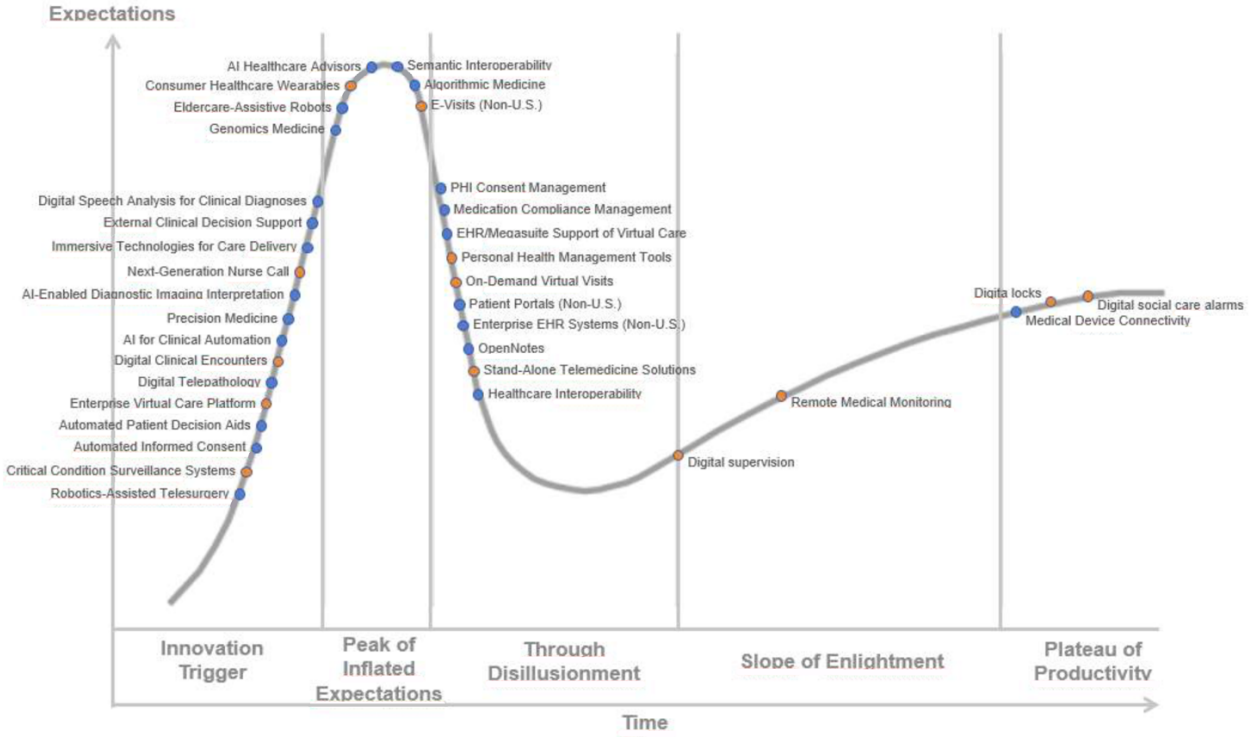


Figure 2.2 - Gartner Hype Cycle for digital healthcare technology (Adapted from Schildt et al., 2018)

2.1.3 Challenges with Integrated Digital Healthcare

One challenge with the implementation of these systems seems to be that the technological development of digital services is fast compared to the time needed to evaluate and test system to

get evidence. SALAR (2018) claims that in other areas, for example the pharmaceutical industry, development processes of 10 years or more are accepted, but when it comes to digital services people expect the development to be as rapid as the rest of the IT sector. At the same time, evidence from clinical studies is highly demanded when implementing all kinds of technology in healthcare, so there seems to be dissonance in expectation and delivery. According to SALAR (2018) the products can either be released to market to get data for evaluation or developed and tested longer, which can lead to a consideration of patient safety and increased costs.

In addition, the digital services are mostly financed by the regions through the Public Procurement Law with different requirements of clinical benefits, costs and data that can be used to make calculations of the health situation in the region (SALAR, 2018). There is reason to believe that similar systems and services are being developed in parallel in different regions on different levels. If the regional, municipal and private healthcare providers operations overlap each other and they use different systems, it can become problematic for the patient (SALAR, 2019). It is important that all parts of the system are identified and coordinated.

Another challenge with digital healthcare services is that they have to be integrated in the healthcare providers' way of working to have a positive effect. According to SALAR (2019) there is no evidence that e.g. remote medical monitoring in itself results in better health, so it seems to be crucial that it should be a central part of the treatment process to be beneficial. However, to have a positive effect, the right data has to presented in the right way. SALAR (2019) describes a British study where patients could measure and view their ECG, and where the number of patients seeking medical attention due to experienced exacerbations or other medical emergencies increased with 79%. In this case the data was just presented to the patients and the healthcare providers way of working was unchanged. This indicates that procedures and organizations have to be adapted to make use of new technologies.

2.2 Virtual Hospital

2.2.1 The concept Virtual Hospital

The Virtual Hospital (VH) is an integrated digital healthcare system under development in a three-year project at HCH. The system is visualized in **figure 2.3**. The main idea is that patients that are treated at home can measure some types of vital parameters by themselves or with help from personnel or relatives. The data is synchronized to the database for the region and can be presented in interfaces for both the patients and their relatives, medical professionals and other personnel. One important application is that medical professionals in hospitals, health care centers and home care services can monitor the patient remotely and detect and respond to changes in their health status.

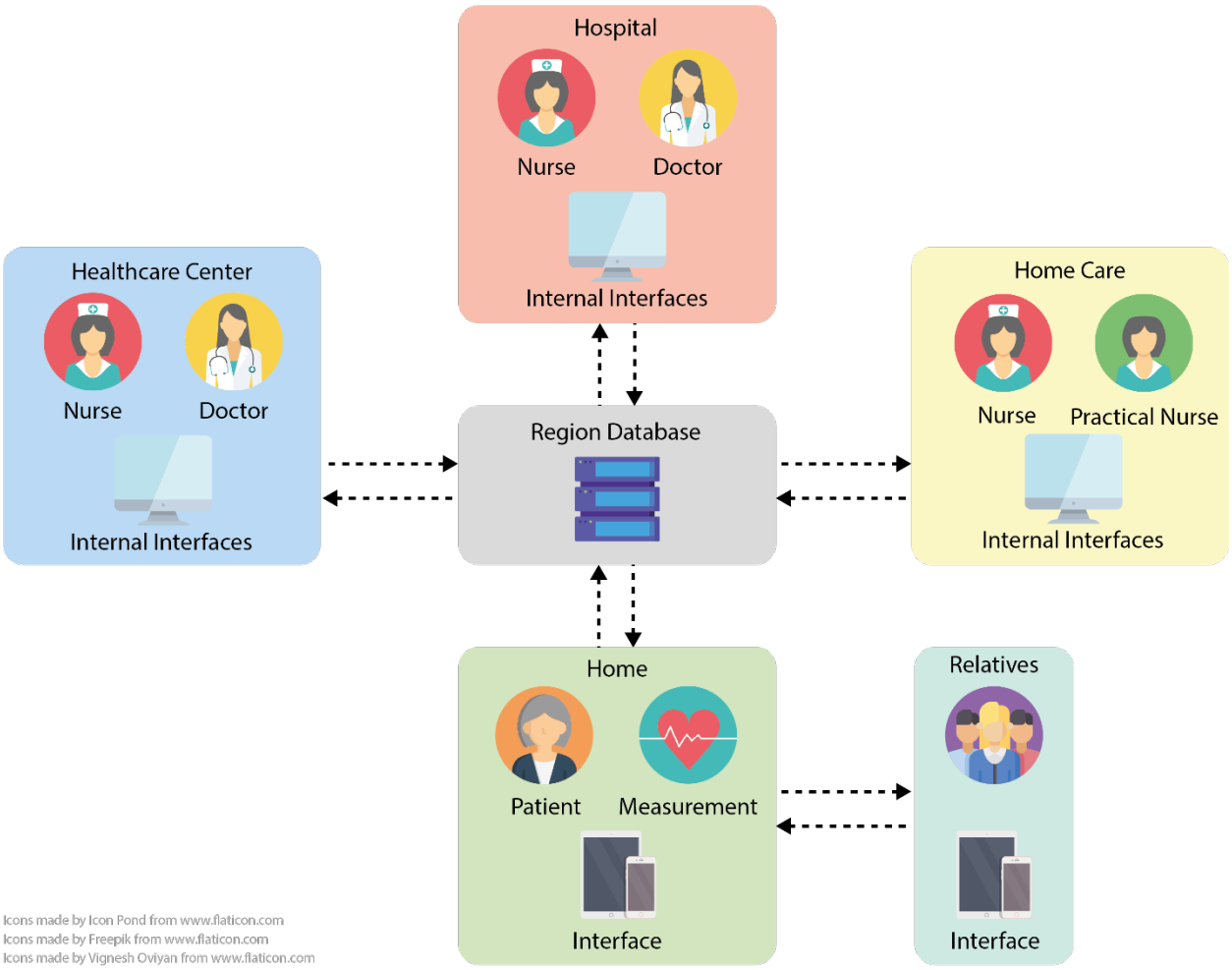


Figure 2.3 - Visualization of the Virtual Hospital system

Region Halland is seen as a good place to test this type of system for two reasons. Firstly, the region only consists of six municipalities, which makes the healthcare system and its stakeholders easier to overview and include in the process compared to other regions. Secondly, the existing database for Region Halland has a lot of stored and sorted medical data from previous studies, and this can be used as a foundation for building a data driven healthcare service like this (Börjesson & Trepte, 2019). In addition, the research on healthcare and AI conducted at Halmstad University and HCH's connections to this are also seen as an advantage. The main challenges that VH will address are the demographics development, where the population is getting older, the fragmented healthcare system and patients with complex healthcare needs. Börjesson & Trepte (2019) also state that the goal is that VH will create a more coherent continuity of patient care and at the same time increase home care treatment.

2.2.2 Halmstad Intelligent Home

Halmstad Intelligent Home (HINT), is a research environment at Halmstad University where innovations for the smart home are being tested (Halmstad University, 2020). Many projects concern health innovation and HINT is strongly linked to HCH. The facility is built and furnished like a standard 50 m^2 apartment and has a variety of sensors for detecting and monitoring activity in the room. The apartment also contains actuators that can respond to the activity, for instance electrical motors to adjust bed positions. Additional systems can also be installed for testing and evaluation of new concepts. The purpose is to provide researchers, students and industry with a realistic home environment and longer studies can be conducted by letting subjects live in the apartment for periods of time (Lundström, et al., 2016). The part of HINT that will be used for this project is the bedroom, see **figure 2.4**.

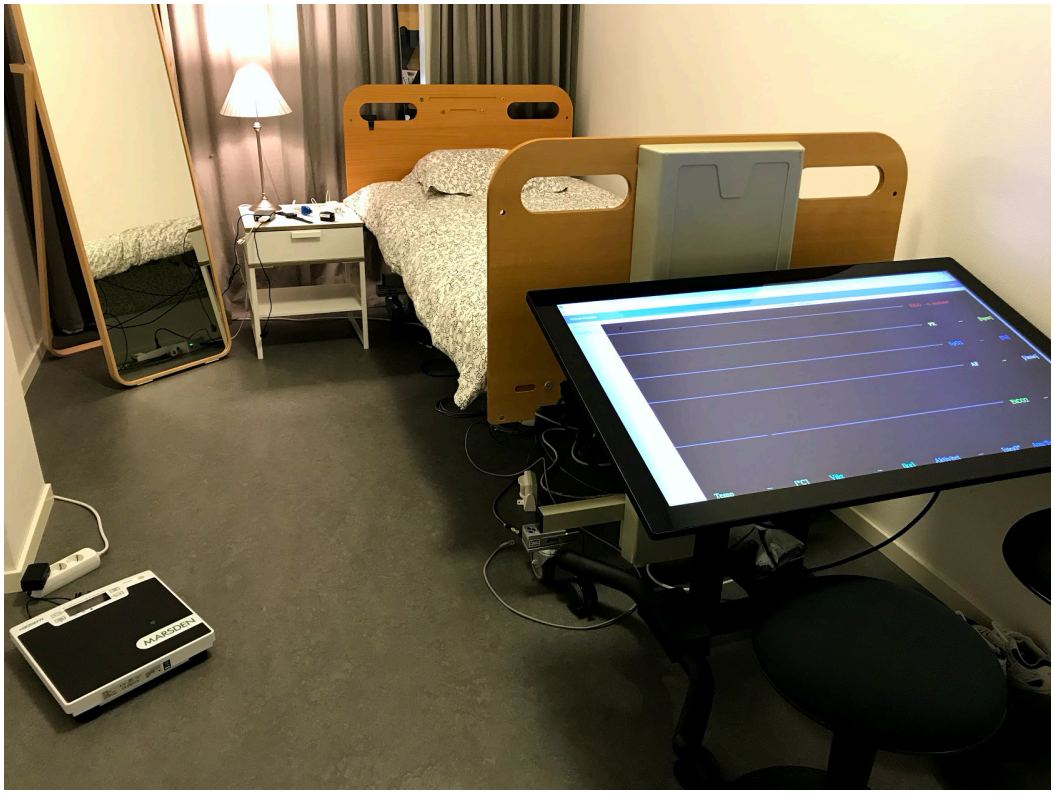


Figure 2.4 - Bedroom in HINT

2.2.3 Prototype

At the initiation of this thesis work, the technological part of the project Virtual Hospital is at a stage where five types of vital parameters can be measured in HINT, and this data is synced to the database for Region Halland. The measurement equipment that is installed can be seen in Table 2.1**.**

Table 2.1 - Measurement equipment in HINT

Nonin Onyx3 9591 Fingertip Pulse Oxymeter	Measures oxygen saturation, pulse rate and respiratory rate	 *Figure 2.5a (Nonin, 2018)*
Garmin Forerunner 235	Measures distance and pulse during activity	 *Figure 2.5b (Garmin, 2020)*
Marsden M-420 Portable Floor Scale	Measures weight	 *Figure 2.5c (Marsden, 2020)*
Beurer FT 95 non-contact thermometer	Measures body temperature	 *Figure 2.5d (Beurer, 2020)*
Masimo ISA CO2 Capnograph	Measures carbon dioxide of expired air	 *Figure 2.5e (Masimo, 2020)*

The collected data is visualised on a FlatFrog, a large touch screen, see **figure 2.6**. Since the data is synced to the regional database, is also possible to view it on other devices in HINT or at a remote location. The interface that shows the medical data on the FlatFrog is a web version of a monitoring system used by medical professionals today.

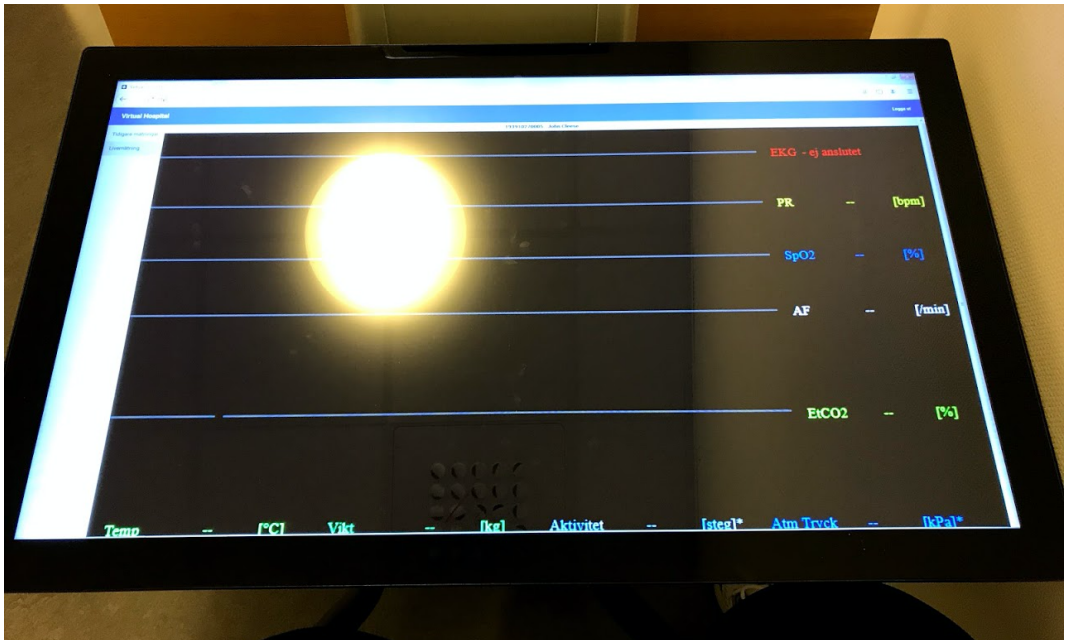


Figure 2.6 - The FlatFrog and its interface in HINT

2.2.4 HCH

Hälsoteknikcentrum Halland (HCH) is an innovation arena in Halmstad, where academia, industry and the healthcare sector collaborate. Focus is on healthcare technology, smart homes and artificial intelligence (AI) and how these innovation areas can be used to meet the challenges that are facing the society and healthcare providers (HCH, 2017). The goal is to help both public organizations and entrepreneurs to create healthcare innovations that can ensure qualitative and accessible healthcare when the load on the healthcare providers increases. According to HCH (2017), the rapid digitalization of the society with individualized applications and services creates demands for similar solutions in healthcare. This can, however, be seen as an opportunity where digital healthcare systems can be used to relieve the healthcare sector.

2.3 Stakeholders in a digital healthcare system

The healthcare sector is a complex system with many actors with different agendas. According to Schildt et al. (2018) the digital healthcare projects that have had the best outcomes are the ones that start with a stakeholder analysis and then focus on the patients' needs during the product

development. Therefore, potential stakeholders in a digital healthcare system are covered in this section, starting with the patient.

2.3.1 Patients

The patient's incentive to use digital healthcare services is to gain control over their illness, to take an active part in the treatment process and to be engaged in life. In order to experience the same safety as in a traditional meeting with a medical professional, the patient has to trust the technology and feel ownership over their data (Schildt et al., 2018). The patient can become reluctant to the service if he or she is not seen as part of the team around the illness. Schildt et al. (2018) claim that many users feel disappointment when a pilot study is finished, and they have to go back to analogous healthcare and see this as a proof that digital healthcare can be beneficial for the patients.

2.3.2 Relatives

Schildt et al. (2018) state that the patient's relatives can have different roles at the same time. In many cases they are also users of the digital service, but they can also act as a form of lawyers and make sure rules are followed. Gaining control over the disease and the treatment situation can allow the relatives to focus on emotional support rather than practical support. Schildt et al. (2018) claim that the relatives must get acknowledgement for their role and knowledge in order to accept a new service.

2.3.3 Healthcare providers

Many types of healthcare providers can be included in a digital healthcare system, and they can be regional, municipal or private. According to Schildt et al. (2018) they all strive to create more qualitative and equal healthcare with the financial resources available. To be able to implement a new service managers and employees have to be open to change, and to be able to choose the right solution for the right group of patients they need evidence that it is working.

2.3.4 Healthcare professionals

Healthcare professionals are the people working in the healthcare sector, e.g. doctors, nurses, assistant nurses, medical laboratory personnel, home care, physical therapists. They want to create qualitative healthcare for their patients, but also get acknowledgement for their work (Schildt et al., 2018). They need medical data to detect changes, make assessments, create treatment plans, but they have to be presented with only relevant data.

When it comes to digital healthcare solutions, healthcare professionals are generally positive and in some studies teams have refused to go back to the previous working methods after finished project. It is, however, important to involve them in the development and implementation of new

systems so that they are given the chance to express their needs and wishes. This seems to be crucial even if the primary target group is the patient, since the system has to be accepted by the professionals to be used. According to Schildt et al. (2018), the medical professionals can counteract the new system if they do not see its benefits, or if they have a low confidence in IT solutions in general.

2.3.5 Healthcare managers

Persons with leading positions in the healthcare sector are in this thesis called healthcare managers. According to Schildt et al. (2018), their main goal is to create more healthcare with the financial resources available. To implement new digital healthcare solutions, they need evidence of what systems and methods are working, and employees that are open to change.

Apart from good leadership, they need knowledge about the process of implementing new systems and changing work methods. The healthcare manager also has to see the financial benefit of their own unit to work toward the change. If the change causes increased costs in one unit, and the positive effects are measured in another unit, the healthcare manager will not see the change as an improvement (Schildt et al., 2018).

2.3.6 Healthcare support operators

Healthcare support operators are the wide range of public and private organizations involved in developing the healthcare sector, e.g. business developers, innovation advisers and public procurement. It can also be organizations aimed at tying together other stakeholders in healthcare, research and entrepreneurs. Schildt et al. (2018) state that these organizations need a high understanding of the system and process in the healthcare sector where the product is to be implemented, in combination with clear and mutual interpretations of the legislation. The healthcare providers must be able to offer the entrepreneurs knowledge and vice versa, or else the technological development will be obstructed. It also important that the support operator's involvement is not apprehended as control and limitation, but instead support and facilitation.

There is, however, a difference in the types of healthcare support operators. According to SALAR (2018), investors are sometimes more reluctant to invest in healthcare technology compared to other area, due to the longer development and testing times, and the more complicated legislation. This can lead to missed opportunities for private companies relying on investment funding. This could give support operators that are funded by the government and not driven by product profit other opportunities, like researching new areas with uncertain possibilities for economic yields.

This can also give HCH a unique role. Being an innovation arena with the goal to support and develop healthcare technology and to tie together healthcare, research and entrepreneurs, it can be classified as a healthcare support operator. Connecting researchers and students with healthcare

providers and authorities to solve problems in society has the chance to target new innovative areas that would risk being missed by private companies.

2.3.7 Medical technology and information technology departments

The healthcare provider's medical technology and information technology (MT and IT) departments are responsible for purchases and operation of digital healthcare technology. They need to understand the organization in which the technology is to be used and the rules and legislation around it. In many cases, the organization around MT and IT is built for a stable but slow development of IT which does not correspond with the situation today, and this can lead to problems (Schildt et al., 2018).

2.3.8 Technical supplier

The technical supplier delivers, installs and maintains the digital healthcare service in the patient's home or in the healthcare provider's facilities. This can be done by an external supplier, or by someone inside the healthcare provider's organization, for instance the MT and IT department. The supplier wants to give the patient a positive experience and increase efficiency in the organization (Schildt et al., 2018). An external supplier's motive is also to get a beneficial deal and generate yields for their owners and investors. They need to understand the organization and its needs, and to test or evaluate the product by the healthcare provider, something that can be complicated since it is hard to measure the quality of healthcare. In addition, it is crucial that the supplier is seen as a part of the development team and not only a supplier.

2.3.9 Academia

The academia researches digital healthcare and patients with chronic diseases and educates healthcare professionals in using digital healthcare systems (Schildt et al., 2018). Their incentive is to take place on the life science scene and to serve as a model for other academies. They will be hindered when they are not getting enough financial resources for research and when they do not find people or organizations to collaborate with.

2.3.10 Innovator

The innovator is the person or the group that investigates the needs and requirements and develops the digital healthcare solution. They want to create innovations that can be of benefit to the healthcare recipients and the healthcare providers. The organization of the healthcare provider is complex, and the innovator needs guidance and support to understand the system and its problems (Schildt et al., 2018).

2.3.11 Authorities and Legislators

Healthcare is regulated by extensive legislation to guarantee good quality and patient safety. The authorities legislate and supervise that the laws are followed. They can also act as funder and handle financial support for development of digital healthcare. The government and SALAR are working toward a vision, called “Vision e-hälsa 2025”. With the help from digital healthcare, the individual shall be in center, and the healthcare shall be equal, effective, accessible and safe (Schildt et al., 2018).

According to Schildt et al. (2018), the stimulation of digital healthcare innovation is obstructed by the fact that the legislation is written for a time when digital systems were not in use. The authors also state that the legislation is based on the structures of the healthcare sector and not on the patient’s needs, and that the result is that information becomes locked in the instance it is created. This indicates that system for sharing data between instances has to be developed in parallel with new legislations, so that more stakeholders can access the information.

3

CASE

3 Case

3.1 Chronic obstructive pulmonary disease (COPD)

The disease in focus in this project is Chronic obstructive pulmonary disease. COPD is a chronic inflammatory condition of airways, pulmonary arteries and lung parenchyma (Andersen, et al., 2010). The illness makes it harder to breathe, for everyday activities it requires more energy and it brings a higher risk of being tired. A patient with COPD shows several symptoms. There is a higher risk to feel shortness of breath (dyspnea) during physical activities and other signs of COPD are coughing with phlegm and wheezing sounds (Mayo Clinic, 2020). A COPD patient is more prone to getting chest infections and losing weight (1177 Vårdguiden, 2018). Unfortunately, symptoms are not immediate and are not evident at first glance. Though the symptoms from COPD are mild in the beginning, they get worse over time.

The age of onset for a COPD patient is later in life, often older adults. It is rare that COPD affects younger adults (1177 Vårdguiden, 2018). According to Socialstyrelsen (2018) there is an estimated number between 400 000 to 700 000 people that have COPD and roughly 3000 persons per year die from the illness. The mortality is increasing, mainly for women, according to the estimated number of unrecorded cases (Socialstyrelsen, 2018). Lungrapporten (2019) assumes that 8-10% of the Swedish population over 45 years of age are affected and that around 30% of those are diagnosed with COPD.

There are two common conditions in the respiratory system that contribute to COPD: emphysema and chronic bronchitis. The severity varies from patient to patient, but the two conditions usually occur together. Chronic bronchitis is inflammation of the bronchial tube lining, which brings air to and from the lung air sacs (alveoli). It is characterized by the development of frequent cough and mucus (sputum). In the second condition, emphysema, the alveoli in the lungs are damaged and destroyed due to exposure to tobacco smoke, irritating gases or atmospheric particulate matter. The inner walls of the air sacs weaken and rupture over time which creates larger airspaces, rather than many smaller healthier ones. This severe condition reduces the surface area of the lungs together with the inhale (oxygen) amount that reaches the bloodstream, making it harder to breathe. When exhaling the damaged alveoli do not function properly and old air becomes trapped, meaning that no oxygen-rich fresh air can enter because the sacs are already occupied with carbon dioxide, thus increasing the likelihood of getting dyspnea.

Depending on how severe the illness is, COPD is categorized in four stages.

Stage 1 – Mild symptoms

Stage 2 – Moderate symptoms

Stage 3 – Severe

Stage 4 – Very severe

COPD is not curable; however, it is treatable. What kind of treatment the patient receives depends how severe the COPD is and the illness' stage. The goal is to decelerate the expansion as much as possible. According to Riksförbundet Hjärt-Lung (2019), the most effective measure is to stop smoking. The typical COPD patient has a long-term usage of tobacco smoking. 1177 Vårdguiden (2018) states that around 50% of people that have smoked for several years have got COPD by the age of 75. Other factors to limit COPD are through training and physical exercise, as working out increases the heart and breathing rate. This increases the lung capacity which reduces the risk of dyspnea and can improve daily life tasks. For the medical treatment, a COPD patient is given pharmaceutical preparations that expand the respiratory system, which makes it easier to breathe and also dissolve phlegm that is difficult for the patient to cough up naturally.

It is common that a patient is examined with an ECG to determine if the patient is affected with COPD, the use of ECG is to differentiate heart diseases as the symptoms are similar (1177 Vårdguiden, 2018). Thus, COPD and cardiovascular disease also occur together, and their coexistence is associated with unhealthier outcomes than either condition alone (Rabe et al., 2018). The COPD patient is also vulnerable to losing weight and malnutrition (Riksförbundet HjärtLung, 2019). Weight loss or thinness is mostly due to the fact that the lungs requires more energy than usual to perform normally. In addition, the energy that is needed for the actual nutrition intake results in less appetite to eat. This causes a ripple effect for a patient with the combination of thinness and COPD, as thinness increases the risk of infection sensitivity, reduced muscle strength, osteoporosis, depression and reduced quality of life (Riksförbundet HjärtLung, 2019). Still, COPD is affecting patients with long time smoking, and younger generations smoke less daily compared to older generations (Folkhälsomyndigheten, 2020). According to Folkhälsomyndigheten, 10% of the Swedish population between the ages of 45-64 and 8% between 65-84 are smoking daily in contrast to 5% for both the age span of 16-29 and 30-44-year-old. One can argue that COPD cases might be reducing over the coming generations but evidence suggests that long time exposure to air pollution from traffic, such as smog, might contribute to development of COPD (Andersen, et al., 2010). Andersen et al. (2010) also found an enhanced susceptibility for people with diabetes and asthma, and giving with the global rise of urbanization (United Nations, 2018) it is possible that the potential decline of COPD cases will be dampened.

3.2 Previous work

3.2.1 Study at HCH

As a part of the project Virtual Hospital, HCH has mapped the stakeholders in a scenario for a patient with chronic disease in Region Halland. They have interviewed one person from each stakeholder group they considered relevant. This was documented in form of interview transcripts, a stakeholder map and a process map of the patient journey for a COPD-patient. One part of this master thesis work is to continue this work and hence this material will serve as a basis for targeting interviewees and creating interview questions and stakeholder maps.

3.2.2 The COPD-project at RISE

The COPD-project at RISE (Research Institutes of Sweden) had a similar goal as this thesis work: to develop a solution for care of chronic diseases in the home with support of IT (RISE, 2020). Two roles were created in the project: a Technical Operator that installed the equipment in the patient's home and taught them how to use it, and a Healthcare Operator who was their firsthand contact, reachable through a video communication software on a tablet. The Healthcare Operator (in this case a nurse) could guide the patient when they measured their own values, and the responsible doctor and the patent's relatives could join the video conversation when discussing the treatment process. Around 80 patients tested the solution and were compared to a control group that did not use it.

According to RISE (2020) the concept worked and the overall feedback from patients and medical professionals was good. The combination of measurement of values, questionnaires and video conversation with a nurse created a feeling of safety and was especially appreciated.

3.3 UX design for elderly

3.3.1 Elderly and technology

A majority of the people with COPD and other chronic diseases can be considered to be older adults or elderly, so when developing a digital healthcare system for this user group their needs have to be taken into consideration. According to Blix & Levay (2018) it is common that elderly find it difficult to use digital services. If the system and user interface (UI) is adapted to their prerequisites however, the possibilities for life improvement seem to be great. Panagopoulos et al. (2019) state that technology can support elderly to stay independent longer, reduce social isolation and offer emergency contact information, but that unresolved usability issues often prevent these users from making use of these benefits. This is supported by (Iancu & Iancu, 2020) who argue that many types of technology are present in elderly people's daily life, but the interaction with it

can be frustrating and stigmatizing. On this topic, Fisk et al. (2009) state that proper attention to design can reduce the frustration of dealing with the technology. There seems to be a great need for technology developed directly for older user groups, and therefore this will be taken into consideration in this project.

Iancu & Iancu (2020) also state that it is a myth that elderly avoid technology, and that this is substantiated when the user group themselves do not believe they are able to learn to use it. In addition to this, elderly are less inclined to use technology for the sake of using it compared to other groups, and hence it must fulfill a need (Panagopoulos et al., 2019). This indicates that apart from adapting the design itself to the elderly's needs, it has to have a clear functional purpose and convince the user group that they can handle it.

3.3.2 Design guidelines

On the topic of elderly and technology, Petrovčič et al. (2018) offer a wider definition of age, where chronological age and functional age both can lead to changes that affect a user's ability to use a product or an interface. Changes in vision, hearing, motor skills and cognitive ability are examples of factors that can create new demands on the technology and show that many areas have to be taken into consideration. Petrovčič et al. (2018) suggest that a list of design guidelines for the older user group can facilitate adapting to these factors in an effective way, a method utilized by both Panagopoulos et al. (2019) and Iancu & Iancu (2020). Hence, a brief review of literature on UX design guidelines relevant for this project has been conducted, and the findings are presented in **table 3.1**.

Table 3.1 - UX design guidelines for elderly

Aspect	Design Guidelines	Sources
Visibility	Larger screen/interaction area	Iancu & Iancu (2020); Petrovčič et al. (2018)
	High color contrast between background and text/objects	Petrovčič et al. (2018); Iancu & Iancu (2020); Fisk et al. (2009)
	Customizable layout that allow hiding of unnecessary functions	Panagopoulos et al. (2019)
	Customizable font size	Iancu & Iancu (2020); Petrovčič et al. (2018)
Interaction	Larger buttons and wider spacing	Petrovčič et al. (2018); Iancu & Iancu (2020)
	Immediate visual, auditory or tactile feedback, preferably multimodal	Petrovčič et al. (2018); Iancu & Iancu (2020)
	Simple and static menus, avoid scrolling and gestures	Iancu & Iancu (2020); Petrovčič et al. (2018)
	Increased time/no time limit to perform actions	Petrovčič et al. (2018); Iancu & Iancu (2020)
Understanding	Symbols and icons can be effective, but have to have a clear meaning, and can take longer to learn	Fisk et al. (2009); Panagopoulos et al. (2019)
	Avoid technical terms, abbreviations and foreign expressions, terminology should be consistent	Petrovčič et al. (2018); Fisk et al. (2009)
	Short animated instructions	Panagopoulos et al. (2019)

3.4 Benchmark

A benchmark was conducted to grasp how medical data could be captured, executed and presented in a user interface for the user. The purpose was also to study and understand layouts and structures in apps to grasp usability and interaction for the user. The benchmark emphasizes consumer products, such as downloadable apps, built-in software and software with accessorial hardware.

3.4.1 Apple

Apple Health, is a developer framework from Apple that integrates health records from various health apps and fitness apps to create a unified user experience for the iPhone user (Apple, n.d.). The user needs to set up a user profile and accept permission for each app to integrate with Apple Health. By transferring data from health & fitness apps to Apple Health, Apple health can capture different health data depending what scenarios the app is designed for and present it in a graphical and comprehensive way. In other words, the user doesn't necessarily need to interact with the health/fitness app itself. Moreover, examples of values are anthropometry values, sleep tracking, heart data, activity, and nutrition. All data is presented in a summary (**figure 3.1**) first and can be selected to demonstrate more detailed data, presented as a graph, about the selected health. The detailed graph (**figure 3.2**) can be sorted by day, week, month and year overview and with an informative text describing more about the health data in an educational way. Lastly, some of the health data can give future prediction based on previous performance and, thus, give feedback to the user.

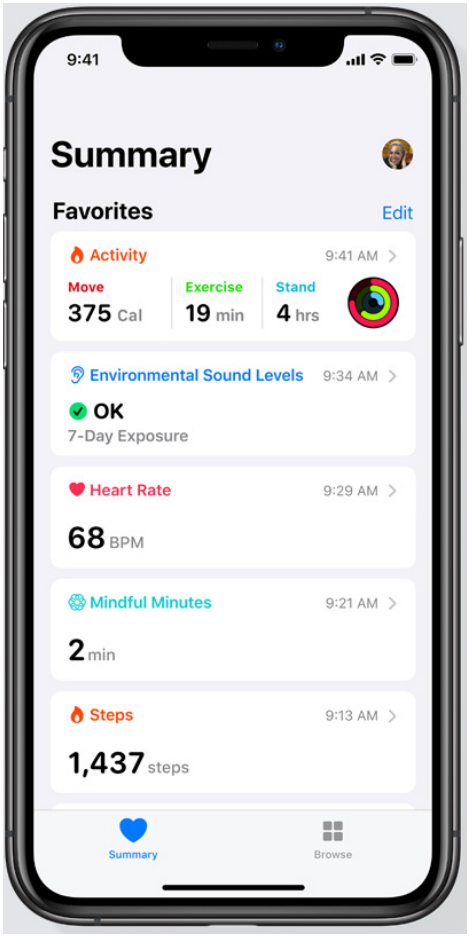


Figure 3.2 - Apple Health Summary overview (Apple, 2020)

Figure 3.1 - Detailed graph for resting heart rate (Apple, 2020)

A wearable is a smart electronic device that monitors, interprets and transmits information about, for example, body signals like vital signs and ambient data, enabling immediate feedback to the wearer (Düking et al., 2016). The wearable is typically worn on the surface of the skin. By using a wearable, more health data can be captured, through Apple Health. A wearable, for example an Apple Watch, is equipped with hardware, such as GPS, gyroscope and accelerometer, and built-in optical sensor. Apple Watch was originally released 2015 and has iterated over the years with new design, better hardware and additional features (Know Your Mobile, 2020). Furthermore, Know Your Mobile (2020) claims that it is the number one best-selling wearable in the world and estimated that over 33 million units had been sold during 2019.

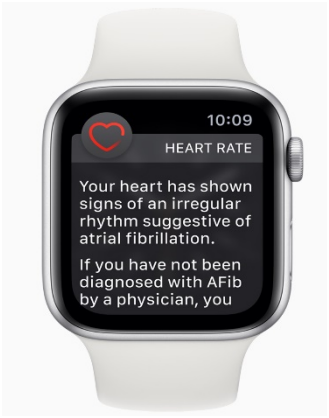


Figure 3.3 - Notification warning for potential atrial fibrillation on an Apple Watch (Apple, 2020)

Figure 3.4 - The Activity rings overview on an iPhone (Apple, 2020)

Also, with the hardware, an Apple Watch can detect the user's activity level and track specific movements, e.g. steps, arm movements and distances. And thanks to its optical sensor it can detect heart rate and other health features (Apple, n.d.). For example, Apple Watch has several built-in health detections to warn and notify about early signs of diseases to the user (**figure 3.3**); high heart rate, low heart rate, irregular rhythm (atrial fibrillation) and an ECG app. The wearable checks the heart rate in the background when it is worn or when the user initiates the heart rate app. It can capture the heart rate and categorize it by current heart rate, heart rate over time, resting heart rate, recovery rate, and heart rate variability. The Apple Watch is a consumer product, but it has the functionality of a medical device, and there are numerous stories where it has been able to detect heart conditions that are potentially severe for the one wearing it. Recently European Heart Journal (2020) reported about an 80-year-old woman who was diagnosed with myocardial ischemia thanks to her Apple Watch ECG app while the ECG instrument at the hospital reported false. She demonstrated the result for the doctors and when she was examined, they were able to detect the disorder, and she was treated subsequently. Lastly, due to liability, Apple Watch cannot diagnose an illness, thus it prompts the user to contact a doctor or emergency, if the user experiences any pain or are not feeling well.

In terms of user experience and user interface, the Apple Watch engages the user to stay active. With its hardware it can track steps, distances and calories burned. All this information is presented as so-called Activity rings and is divided into three rings (**figure 3.4**): Move, Exercise and Stand. In short, the Move ring is the personal goal of how many calories are burnt, the Exercise ring tracks brisk activity, and the Stand ring tracks sedentary behavior. The user gets notifications throughout the day to remind about the rings and to stay active to reach the set goals. All rings are reset each day and every week the Watch suggests new Move goals based on the previous week's activity. Moreover, there is a calendar overview, on the complementary app on the phone, that displays the rings' progress in a more comprehensive way. Lastly, there is an achievement system that gives rewards for different progress that is accomplished, and these achievements can be shared with other Apple Watch users as a way to compete and encourage each other to be healthier.

Notable: Apple Health and the Apple Watch served as a favorable benchmark tool throughout the project, as these devices were always available for comparison, and easy to access when iterating and discussing during the process of this project.

3.4.2 User Interface designs in apps

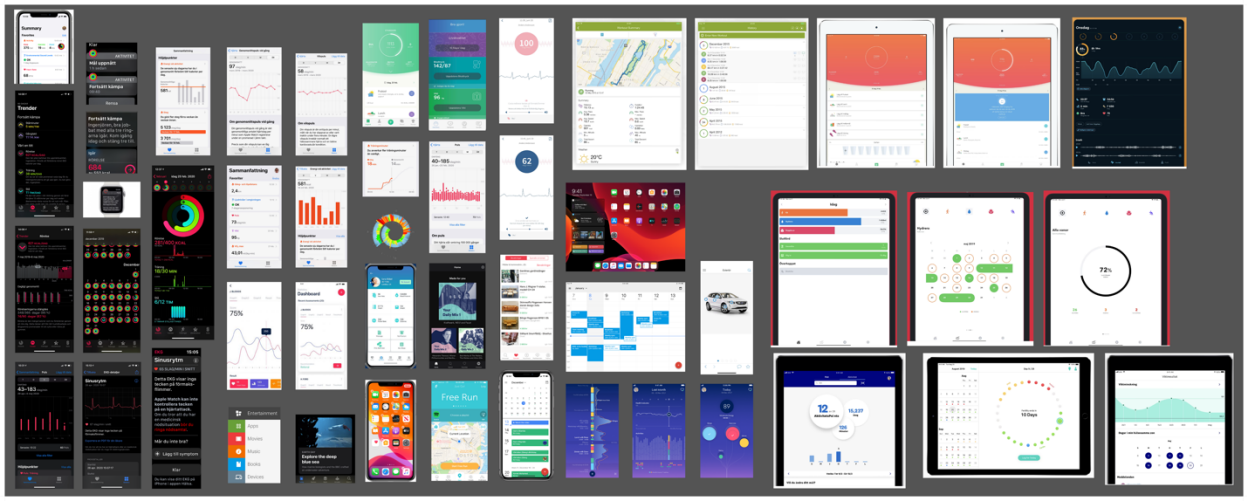


Figure 3.5 - Benchmark board with various user interfaces

In order to avoid being biased and centered around Apple's product line up and ecosystem, a second phase of the benchmark was conducted. One of the purposes was to evaluate differences and similarities between consumer apps and enterprise apps that center around healthcare. However, to gain more inspiration, some consumer apps that were not connected to healthcare were also included, for example Google Calendar and Spotify. The second purpose was to understand how health data can be presented in user interfaces. The third and last was to understand how apps utilize layouts on bigger screens, such as on a tablet. Moreover, the goal was to observe common user interface patterns, elements and layouts and reprocess the observation during the

Create phase for consistency. All the apps that were observed can be found in **table 3.2**. Lastly, the observation was conducted by placing print screens of apps' user interfaces on a digital template in Mural (**figure 3.5**).

Some of the observations that were noted during the benchmark were: placement of buttons, interaction location, animations and graph styles, menu options, access settings, and advanced menus.

Table 3.2 - List of the apps evaluated for the benchmark

Consumer apps	Endomondo, WW – WeightWatchers, Lifesum, Spotify, Volvo On Call, Blocket, HabitMinder, Runkeeper, SleepCycle, Google Calendar
Health Oriented Apps	Biovotion, Coala, ImagineCare

3.4.3 Learning the design process for a User Interface

A short study was conducted to better understand how the process of developing a User Interface works. The purpose was to learn more about how similar or different the design process is for a user interface contrary to a design process involving, for example, a physical product. The information about the subject was gathered through GOTO Conferences (2013)**.** It can be argued that there are similarities and differences in the design process, whether it is a physical or digital product. The most noteworthy thing the processes have in common are personas and sketching. Personas are a fictional description of the target user group. However, when creating personas for a user interface, GOTO Conferences (2013) emphasizes to include experience with technology and IT. Furthermore, the second similarity is that sketching ideas of potential solutions and interfaces is done in an early stage in both of the processes, including discovering design ideas, iteration and identifying potential problems. Also, both processes are about exploring and funneling down ideas before moving to a final design. However, in the user interface process, coding is also included when completing the UI, meaning that last minutes changes can be a time-consuming hassle if changes are made in a later stage of the process. GOTO Conferences (2013) describe that there are several steps to consider when designing for a user interface. In short, they can be reduced to 5 steps.

1. Create Personas with emphasis on IT-experience
2. Layout screens with post-it - add arrows for interactive buttons
3. Draw sketches of potential layout
4. Create a wireframe
5. Apply the graphic design

As mentioned before, the first step is creating personas to describe the target user group. The next step is to create the structure with, for example, post-it notes to map the screens that need to be included. Once the structure is laid out, adding arrows between the post-it notes allows the designer to highlight navigations between the screens. The third step is to design and iterate ideas for potential screen designs. The fourth step consists of translating the design ideas, often from analog into digital interaction, to what is called a wireframe. A wireframe (**figure 3.6**) is used to lay out the content, functionality and interaction for the screens. It is made at a structural and basic level and without adding the graphics: in other words, a skeleton or blueprint of the user interface. Noteworthy, in this step it is possible to do e.g. usability tests with the target group and discuss the layouts between designers and programmers. Finally, the last step involves adding graphic design to the user interface, using a graphic profile such as a logotype, typography, color palette, graphic elements and information of how they should be applied.

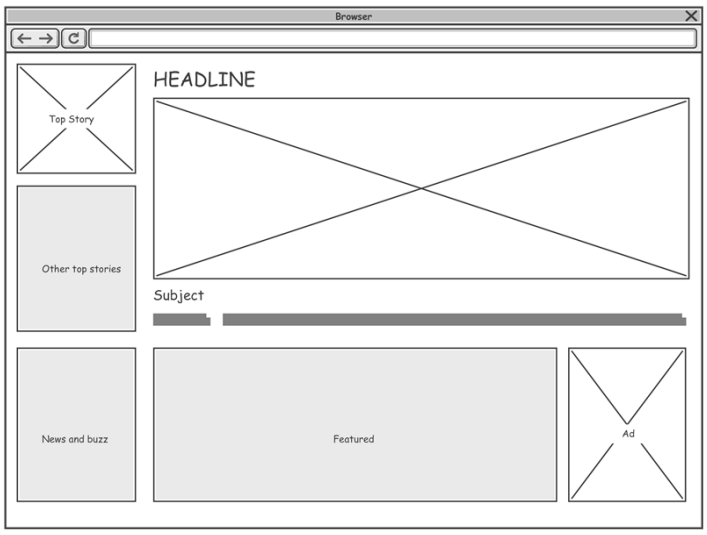


Figure 3.6 - Wireframe screen for a desktop website (Archimetric, n.d.)

4

EXPLORE

4 Explore

4.1 Introduction

In the Explore phase, insights on different stakeholders and their needs were gained. The phase included mapping and analysis of stakeholders in combination with user research. At the initiation of this project the healthcare recipient was selected as the primary user of the digital interface, and the healthcare provider was selected as the secondary user. Patients with chronic diseases, mainly COPD, were selected as the target group for this project. To gain knowledge of the treatment of COPD, patients and medical professionals were contacted and interviews where planned.

Unfortunately, the realization of these was obstructed by the outbreak of the Coronavirus COVID-19. During this phase of the project, the risk of spreading the infection in Sweden was raised to high and measures were taken to prevent this. The virus was considered dangerous to elderly and people with respiratory diseases and the recommendation from the Public Health Agency of Sweden was that unnecessary contact with these groups should be avoided. With the target group selected in this project being a part of the risk group of the virus, these persons became unavailable for meetings and interviews. When the Coronavirus spread in the society the load on the healthcare sector was increased, and it became noticeably more problematic to find medical professionals that could take part in interviews. Despite this, four one-hour long interviews with specialist nurses working with COPD could be conducted, serving as acquisition of qualitative data. With these nurses being the central figure in the treatment process of COPD patients, detailed information on the examination, treatment and monitoring of COPD patients was gained. In addition to this a workshop with stakeholders and a stakeholder analysis was conducted. The interviews and the workshop provided a broad knowledge base, functioning both as evaluation of the project VH for HCH and as foundation for the development of the interface in this project.

To reduce the spread of the virus, the government also decided that students in higher education and many employees in offices and businesses should work from home. Due to this, the latter stages of the Explore phase, including the stakeholder workshop and the processing of insights, were performed remotely with the use of digital communication tools. This required rescheduling and some new strategies, but it did also provide valuable insights about performing this type of workshop remotely.

4.2 Aim

The aim of the Explore phase was to gain understanding of which stakeholders are included in the treatment of chronic diseases today and their roles and relationships. Insights on how the medical professionals work, what takes time and what they use to assess the medical condition of the patient

were considered valuable. The aim was also to understand how the medical professionals could benefit from the Virtual Hospital, and which data and functions they would like to see in the digital interface.

4.3 Methods

To gain insight into the treatment process of COPD, the medical professionals' work procedures and the patients' situation, interviews with COPD nurses were conducted. To better understand the state of the project VH and the different actors involved, a stakeholder analysis in form of a workshop was conducted.

4.3.1 Semi-structured interviews

In a semi-structured interview, the interviewer follows a prewritten guide, while still giving the interviewee the possibility to talk freely. Areas of interest and some questions are formulated before, but the interviewee can focus on things that are important to them and add opinions they want to express, which increases the change that their issues are addressed in the solution. At the same time the guide ensures that the necessary information is gained, and this makes the conversation effective but flexible (Wikberg Nilsson et al., 2015).

A guide for semi-structured interviews with medical professionals working with patients with chronic diseases was created, see appendix 11.1. The interview was divided into two sections; the first part covered their work today, their use of medical data and their social contacts with the patients, while in the second part the concept of the Virtual Hospital was explained and the system illustration (see **figure 2.3**) was shown. This part of the interview covered their views on VH, if and how they could benefit from it and if they would like to see any other functions than the ones suggested.

Four interviews were conducted with specialist nurses working with chronic patients. Two took place at a lung clinic and two were phone interviews. The interviewees worked at different hospitals and the use of digital healthcare systems varied between these. For instance, at one clinic all measurements of medical data were made during a 3,5-hour hospital visits, while at another clinic a system where the patient reported some measurements on an iPad was tested. The attitude towards the implementation of digital healthcare systems in general was also different between the interviewees. These differences in familiarity with technology and attitudes towards new systems resulted in that relatively different viewpoints were represented by these relatively few interviewees.

4.3.2 Rose, thorn, bud

This method is used to process and sort qualitative research data from interviews, observations or workshops. The participants statements about a situation, an idea or a product are sorted into three categories: roses, thorns and buds (Mural 2020). Roses are positive opinions, thorns are negative opinions, and buds are issues that need more work or completely new ideas. This can be visualized by writing the statements on sticky notes in three different colors, as seen in **figure 4.1**. The color coding helps visualize which type of intervention the different statements require. For a product or an application, many roses could indicate a solution suitable for the target group, while many thorns could indicate that big changes have to be made. In addition, many buds may indicate that there is great possibility to add new innovative functions. In this project, the Rose, thorn, bud-method was used to process and sort the interview data, and to highlight areas of interest for the development of the digital interface.

4.3.3 Affinity diagramming

Affinity diagramming can be used to process research data and is an effective way to sort and group interview insights. The observations, concerns, requirements and other statements from the interviewees are written down on sticky notes, and these are placed in groups based on affinity (Hanington & Martin, 2012). The groups are not predefined, instead notes with similar themes are clustered together and the name of the group is formulated and updated along the way. This creates an iterative process where overarching themes from all the interviews can be found, which makes the research data organized and more accessible.

This method can be used effectively together with the Rose, thorn, bud-method, by creating affinity clusters from the color-coded notes. This helps to highlight interesting areas, for instance a group with many thorns could indicate that many interviewees have mentioned problems, so that it needs more attention. To further analyze the data, relationships between the affinity clusters can be discussed, formulated and visualized with arrows. This creates and overview of how the groups connect to each other and affect each other. Visualizing which group is dependent on which also helps highlighting where more attention and work is needed to improve the overall situation. The layout of the Rose, thorn, bud-method in combination with Affinity diagramming can be seen in **figure 4.1**. This method was used to organize the research data from the interviews.

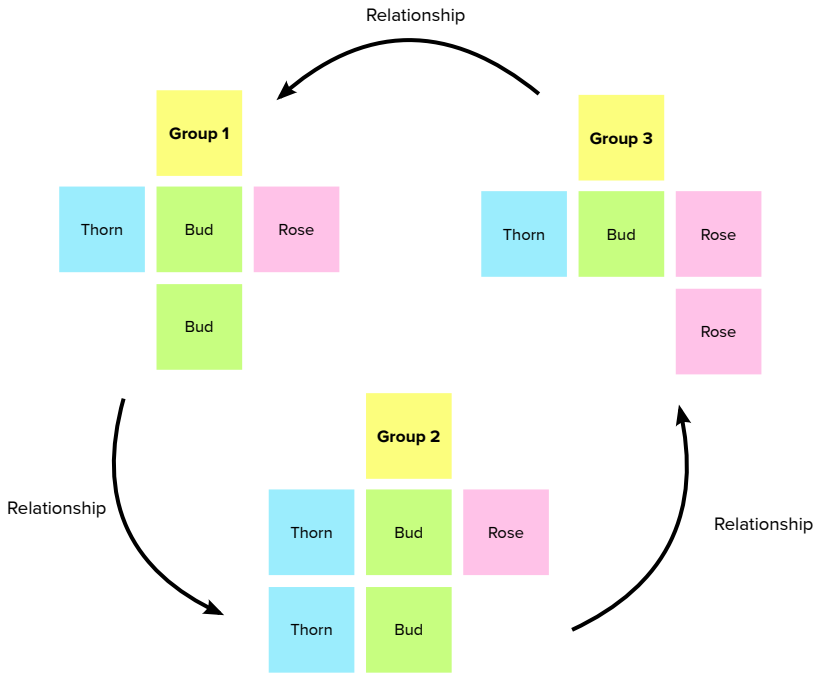


Figure 4.1 - Layout of Rose, bud thorn and Affinity diagram (Mural, 2020).

4.3.4 CHAI analysis

Change Agent Infrastructure (CHAI) is a method for analyzing stakeholders in ergonomics- and work environment-related change projects (Berlin et al., 2017). The analysis can be performed at the start of a project, in the middle of a project or after the project is completed. At the start of the project, the analysis can be used to determine relevant actors and facilitate planning. During the project, it can be used to evaluate if some actor's roles must be altered. At the end of the project, the method can be used to evaluate if the result of the change can be connected to any actors or other factors (Berlin, CHAI Quick Guide, 2019).

One way to perform the analysis is through an interactive workshop session with colleagues, stakeholders and other people with useful insights in the change project or the organization that is to be changed. The process can be documented in matrix of sticky notes, as seen in **figure 4.2**. This creates a visual mediating object that can be easily engaged with and referred to, which can increase presence in the moment. The workshop can be performed in five steps, described below as steps 0-4 (Berlin, CHAI Quick Guide, 2019).

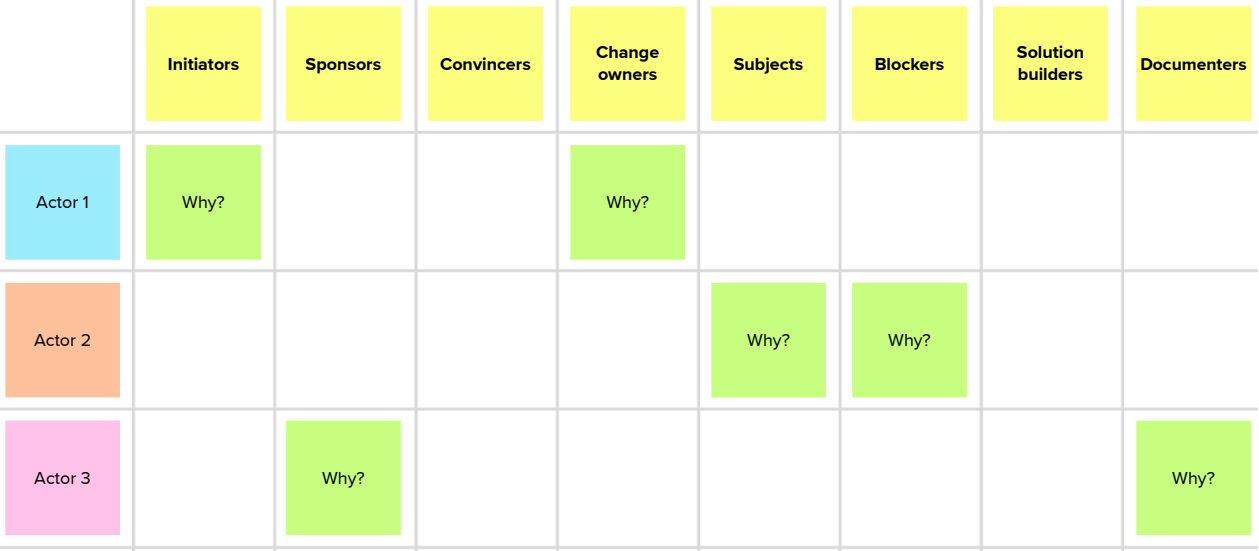


Figure 4.2 - Layout of the CHAI workshop matrix (Berlin, CHAI Quick Guide, 2019).

(0) At the start of the workshop, the change should be clearly formulated, and the future stage that are to be achieved should be defined. This serves as a basis for the discussion and makes sure that all participants refer to the same change. (1) Then the participants are asked to list potential stakeholders involved in the change project. The actors are marked with notes on the left. The actors can be human or non-human, for instance users, managers, organizations and laws. (2) Each stakeholder is then mapped against eight predefined roles that can facilitate or hinder the change, by selecting the roles with a description that corresponds to that particular stakeholder. The eight roles are described in **table 4.1**. The roles are marked with yellow notes on the top of the matrix. For each match between a stakeholder and role, a motivation for the selection should be included, to clarify how and to which extent the stakeholder fits into this role. The motivation is written down on the green notes in the matrix. Motivating *why* a certain actor matches a certain role is a central part of the exercise, since it requires the participants to find the connection between the actors and the change, based on interests, motives and influence (Berlin, CHAI Quick Guide, 2019). (3) To utilize the result of the populated matrix, each role can be looked at individually. Roles with no or few actors should be identified, since this could obstruct the realization of the change. (4) Furthermore, actors with many different roles should be identified. This could mean conflicts of interest and that they require more decision support.

Table 4.1 - The eight predefined roles in the CHAI analysis (Berlin, CHAI Quick Guide, 2019).

Role	Definition
Initiators	Initiators bring attention to the problem or underlying need for change and place it on the official agenda to be dealt with.
Sponsors	Sponsors are not directly affected by or active in the project, but support and maintain the legitimacy of the change morally or with resources and keep it on the agenda.
Convincers	Convincers use evidence (statistics, studies and reports) to convince others that the need is legitimate, and that change is required.
Change owners	Change owners are assigned legitimate ownership of the change/project. They are assigned to ensure that the problem is resolved (or that the change is implemented) and has the mandate to determine when the change is satisfactorily implemented.
Subjects	The subjects or those who are recipients of the change are directly affected in their activities by both the origin problem (if left unresolved) and the proposed change. They may have limited influence, but their acceptance of the solution or change may be key to the success of the implementation.
Blockers	Blockers have reason to prevent, delay, shift focus and resources from, or simply stop the change. The change may involve a threat or conflict of interest for them. Finding out their reasons may be valuable input towards adapting the change and gaining acceptance. An actor may also become a blocker inadvertently, by having insufficient time or resources to give to the change project.
Solution builders	Solution builders contribute wholly or partly to the design and implementation of the change, with expertise, feedback, resources, or practical action. Their combined effort is approved by the *Change owner* to determine whether the change is sufficient.
Documenters	Documenters document the problem formulation, requirements, decisions made, quality criteria and the design/execution of the change. A variety of actors may be responsible for different parts of documentation, which may lead to it being spread out in different formal and informal forums and mediums.

In this project, a CHAI workshop was conducted with a selection of people with knowledge about the project VH, and people with knowledge about the healthcare sector in Region Halland. The workshop was held through a virtual meeting in the video communications program Zoom, and it was divided into two two-hour long sessions. The sessions were recorded so that further insights from the discussions could be gained later. Three representatives from HCH with different connections to VH took part, together with a head of unit from the region and a coordinator from the municipality. In addition, the two authors of this report functioned as moderator and secretary. Instead of a physical note board with sticky notes, a digital note board using the workspace collaboration website Mural was used. The participants received a view-only link so that they

could see the matrix get populated with sticky notes and discuss the result, and the secretary updated the board with the participants' statements and opinions. The layout used for the workshop can be seen in Appendix 11.2.

The participants had been sent the CHAI Quick Guide (Berlin, CHAI Quick Guide, 2019) by email beforehand, so everyone had a brief understanding of the goal and procedure of the workshop. The formulation of the change had been discussed and agreed on with the representatives from HCH. This formulation was written above the matrix and read out loud at the start of the workshop, to clarify for everyone which change should be discussed. Following this, the description of the eight roles, see **table 4.1**, were read out loud and the participants had the possibility to ask questions. Then the steps described above, 0-4, were followed, with some practical alterations due to the workshop being held remotely. When the matching roles for an actor should be determined, the participants were asked to vote on the roles that they believed matched. This was done so that everyone's opinions would be brought to light and not get lost due to the remote communications. The voting was conducted with use of a polling function in Zoom. At the end of the workshop, a general discussion about the result and what it means to the project took place, where the participants could talk freely.

4.4 Results

4.4.1 Interview insights

The affinity diagramming of the interview insights resulted in eight areas of interests and relationships between these. The result can be seen in **figure 4.3** and the insights on the different areas of interest are described in detail below.

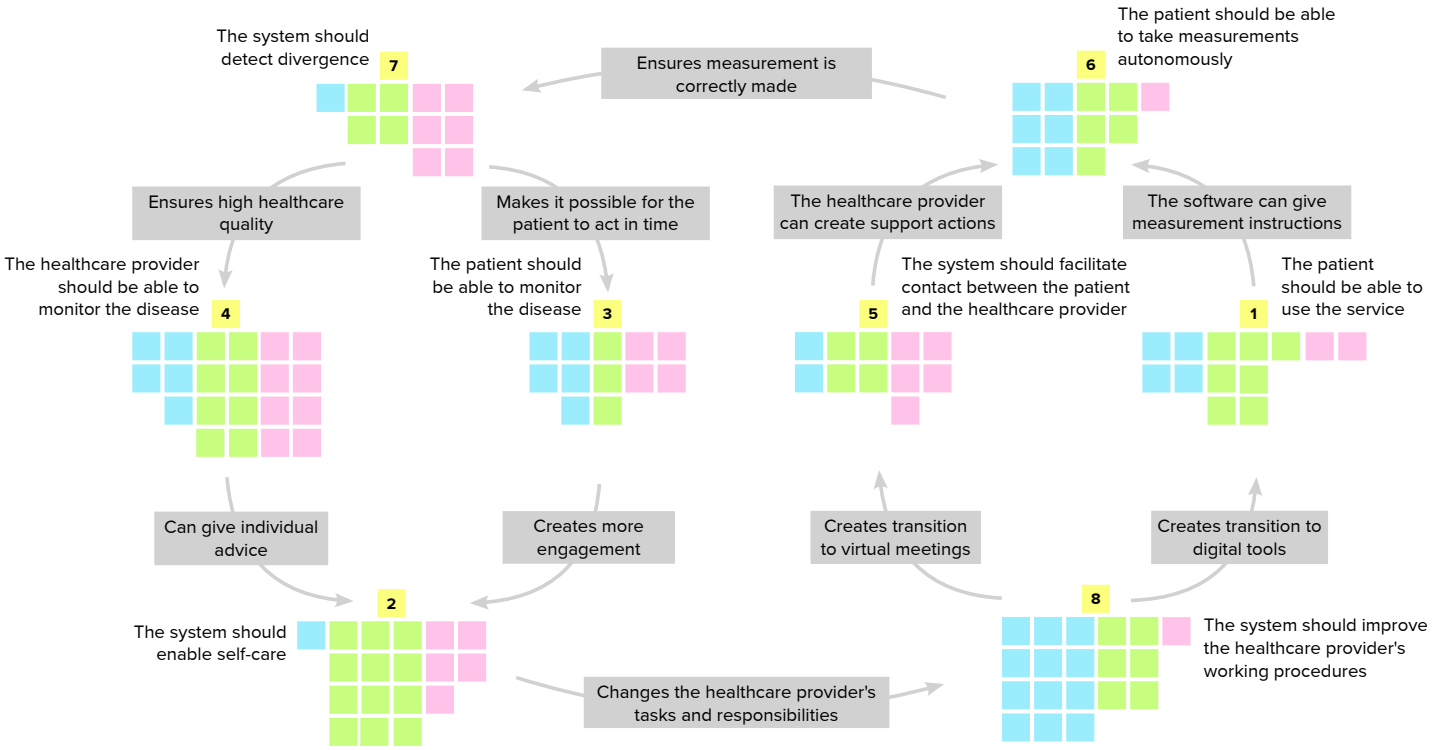


Figure 4.3 - Overview of the eight areas of interest with color coded insight notes and their relationships

1. The patient should be able to use the service

The patient's ability to use the service was considered to be fundamental for the Virtual Hospital. All participants stated that the values presented to the patient have to be explained, including what they mean, what is normal and what to do when a value is getting worse. Apart from explaining this in the UI, an idea was to teach the patient how to interpret the values at the hospital when they are given the equipment. A frequent comment was that a service like the Virtual Hospital is not for all patients and that it has to be individually adapted. The technological experience can differ greatly, and self-confidence is needed to perform the measurement and trust the values. In addition, it can be difficult to remember to do this. On the other hand, some participants mentioned that younger patients can be used to a higher level of technology and expect the healthcare sector to offer services that matches this. Another issue regarding the service was the handling of data, with questions like who owns the data and who has access to it? This has to be clarified for the user.

2. The system should enable self-care

All participants stated that functions that could enable and facilitate self-care would be a good utilization of the Virtual Hospital. They expressed that self-care is an important part of the treatment of COPD that can improve health and reduce the need for hospital visits. Today the information on self-care is usually communicated to the patient in the form of a rehabilitation plan

in a physical document. This is sometimes impractical since the document can be lost or ignored, and hence it was suggested that these instructions and advice could be included in the UI. The system could remind and motivate the patient to be physically active and it could include a training program where movements and exercises are shown. On this topic, it was stated that the physical therapist is important to help the patient with the movements, and that the occupational therapist is important to teach them energy-conserving techniques for everyday activities Perhaps these roles could connect with the patient through the system. Smoking cessation was also described as a fundamental part of the self-care, and the first step of every COPD treatment. There are applications and services for this on the market, but perhaps similar functions could be included in the Virtual Hospital.

Another possible feature that was mentioned was medication advice for COPD patients, primarily regarding inhalers. It could be useful to be able to instruct the patient how to use the inhalers, either with an instructive video or by a medical professional through a video call. One participant also suggested that a video call could be used to clarify which combination of inhalers the patient is using, by showing these on the camera. A recurrent opinion in the interviews was also that more knowledge about the disease itself is good for the patient. In this topic educational features about COPD and how it affects the body was suggested. Lastly, no participant was generally negative to including self-care advice in a system like the Virtual Hospital, but it was stated that the patients' health status changes from day to day and is dependent on external factors like weather. Therefore, there seems to be a need for a flexible system that adapts the self-care advice to different situations.

3. The patient should be able to monitor the disease

The idea to make the measured values and other health data available to the patient was met with both enthusiasm and skepticism. The main advantage stated was that patients that take part of their health data can get more engaged in their disease and their situation, which makes the treatment easier. It was mentioned that some patients find security in measuring their own values and are already buying their own equipment for this. An issue today is also that COPD patients often make many visits to different medical professionals regarding their illness, and that this can be exhausting for them. To receive information on their condition at home could make life easier for them. The main disadvantage of making the health data available for the patient that was expressed was that it can make them worried if they do not know how to interpret it. One participant stated that the measured values are just one component of the assessment of the health status, and that the values are difficult to understand for the patient. It was stated that the patient needs tools to assess their overall health status in combination with the values. Another issue that was mentioned was that the patient can be fixated with the values, so that their life becomes all about taking measurements. There seems to be a need for clear directives, and perhaps limitations on how often measurements can be taken.

4. The healthcare provider should be able to monitor the disease

The idea to make the measured values available for the healthcare provider and enable remote monitoring of the disease was also met with different opinions. The participants that were positive to this feature saw great value in getting more medical data measured frequently over time, since this could give them a detailed view of the patient's health status over a certain time period. In addition, the possibility to take measurements at different times of day and during different activities, like walking, exercising or laying down, could give them even more knowledge of the health status. It was also suggested that the patient could be more relaxed at home than at the hospital, so that this type of measurement could be beneficial. In general, the possibility to monitor the patient's health status remotely was considered useful by these participants, but primarily as follow-up of a hospital visit, and to monitor the patient during the time between visits. All participants expressed that physical meetings with patients are necessary, but some participants believed that a system like the Virtual Hospital could reduce the overall number of hospital visits greatly and relieve the healthcare sector.

The participants that were skeptical to remote monitoring of COPD in the Virtual Hospital stated that the measured values alone were not so useful, and that they needed to see the person physically and speak to them in order to assess their symptoms and exacerbations. The patient's own description of how they feel in their everyday life and what they are capable of seem to be an important part of this. On the other hand, forms for COPD Assessment Test (CAT) and Medical Research Council (MRC) were mentioned as useful tools to assess symptoms and exacerbations, and one participant suggested that these could be utilized in the Virtual Hospital. In these forms, the patient themselves fill in their experienced level of cough, shortness of breath, energy etc., on a numbered scale so that the medical professionals can get a quick indication of how the patient feels.

On the topic of remote monitoring, it was stated that it would be good if all healthcare providers could access it. One participant suggested that many different medical professionals could make use of the data, since the patients are often multimorbid. Nutritionists were mentioned as an example, since COPD patients often risk losing weight. Body mass index (BMI) was considered a useful value for nutritionists, and since weight and height can be measured relatively easily by the patient, these values could be effectively implemented into the VH.

5. The system should facilitate contact between the patient and the healthcare provider

All participants stated that physical meetings are necessary, but some participants saw great value in facilitating communication between these appointments. The possibility to instantly contact a medical professional through a virtual meeting to discuss their situation was considered to increase the feeling of safety for the patient. Possible reasons for the patient to seek contact could be to discuss the disease in general, to get feedback on their measurements or to talk about their anxiety.

On this topic, it was stated that COPD can be shameful and that the patient risks being isolated because of this, so that the need for support can be high. It was also suggested that the responsible nurse in the municipality could be included in the virtual meeting.

The opinions on voice calls versus video calls differed greatly. Two participants expressed that a traditional voice call is enough when communicating with the patient between the physical meetings, while the other participants stated that it is important to see the patient. In the latter case, the wish to be able to see the patient during the conversation seemed to be based on two functions. One function would be to recognize the patient from the physical meeting and from previous video calls, while another function would be to facilitate assessment of the patient's medical condition by their appearance in the video. As a final note, it was emphasized that it has to be clear who the patient should contact in different situations, for example emergency services in acute situations.

6. The patient should be able to take measurements autonomously

The idea that the patient themselves should perform the measurements was met with both optimism and skepticism. In general, some types values seem to be more suitable for self-measurement than others, and it seem to be important to teach the patient what to do with the values. In most cases, the patient has no medical knowledge to assess if the values are good or bad, and this can make them stressed. Without this knowledge, it is also hard to know if the measurements are correctly made, which can increase anxiety for the patient. One opinion was that the values used in the VH have to be very concrete and easily interpreted. This also places demands on the equipment, that has to be both medically approved and easy to use by the patient. To ensure that measurements are correctly made, it was suggested that home care services could assist the patient during this procedure. The possibility to further educate home care services employees about COPD, measurements and inhalers through the VH was also suggested.

7. The system should detect divergence

The idea that the VH should be an active system that detects divergence in the patient's values automatically and notify the medical professional was met with positive response from all participants. The time between physical meetings with COPD patients can be six months or longer, and during this time it would be useful if divergent values could notify the medical professional automatically. It was also stated that COPD patients sometimes wait too long before contacting the hospital when they experience an exacerbation, and that an active system could decrease the risk that this type of divergence does not become noticed by the hospital. One participant suggested that the medical professional should be able to specify "alert values" for each patient, so that the system would warn when the patients values went over or under this value.

8. The system should improve the healthcare provider's working procedures

Many aspects of how the VH can affect working procedures were mentioned. Starting with the positive statements, time can be saved when the medical professional knows more about the patient before the hospital visit. During the hospital visit notes and medical data can be typed directly into the VH and patient's profile. The patient can get information about their disease and the treatment plan through the VH at home instead of being given a pile of paper at the hospital. It was stated that canceled hospital visits when the patients are unfit to travel are a big issue today, and that virtual meetings could be used in these cases and facilitate planning.

When it comes to the negative viewpoints, they were mostly based on the opinion that there are well-established working procedures and that there is no reason to change these. One opinion was that it would be better to spend money on more employees than on this type of technology. Another participant felt tired of this type of proposals, since it did not solve what they considered to be the main problem: manpower shortage. One participant did not like the idea that the patient should take measurements on their own, since there are educated professionals for a reason. In addition, there seemed to be a concern that this type of system would increase the workload instead of decreasing it. Many patients per medical professional, and systems that do not communicate with each other were raised as possible risks.

4.4.2 CHAI insights

The change formulation that was agreed on with HCH was:

Implementation of a digital system that connects healthcare providers within region and municipality with patients at home, and relieves the healthcare sector through remote monitoring and support of self-care.

The participants proposed 13 actors, which can be seen on the left side in **figure 4.4**. When the roles for each actor were identified, the participants experienced that some actors matched many of the eight roles, up to seven out of eight roles for one actor. However, where some role descriptions seemed to match the actor perfectly, others only matched partially. To be able to distinguish which roles were perfect matches and which only matched partially, the matches have been weighted, and this is visualized with the size of the green circles in **figure 4.4**. The 13 actors are listed below, and for each actor the roles identified by the participants are listed, starting with the strongest matching role. In addition, the motivation for the role selection and other opinions expressed by the participants are included. For some actors, a longer discussion took place, and for these cases a summary of the workshop discussion is included. This is followed by a summary of the workshop discussions for each role, regarding the number of matching actors and what the participants think it means to the project. Lastly conclusions based on the populated CHAI matrix and the participants' discussions are made by the authors of this report.

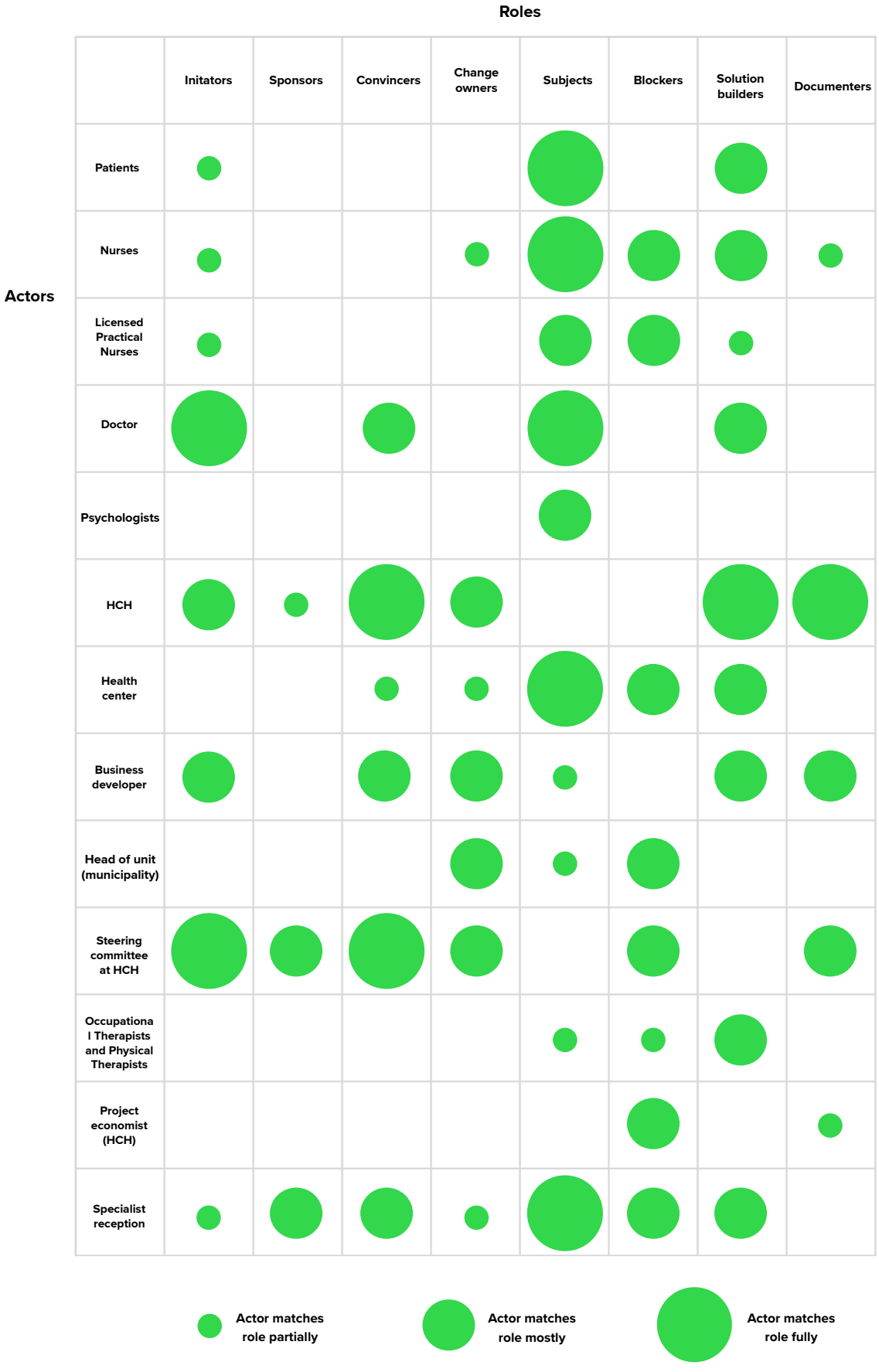


Figure 4.4 - Populated CHAI matrix

Actors

Patients

- **Subjects** (Matches fully). All participants identified the patients as subjects, since they are directly affected by the change when they have to interact with a digital service from the hospital, and since they have to be actively engaged in it.
- **Solution builders** (Matches mostly). The patients should, if possible, take part in finding the solution. They can contribute with experience, expertise and feedback on what is needed.
- **Initiators** (Matches partially). The participants agreed that the patients bring attention to the problems around the disease, but not around digital healthcare in general.

Nurses

- **Subjects** (Matches fully). Have to use the digital service and are directly affected by the change.
- **Solution builders** (Matches mostly). Contribute with experience, expertise and feedback.
- **Blockers** (Matches mostly). There can sometimes be resistance to the implementation of new digital systems in an already overpopulated infrastructure. The nurses can also block the change indirectly if they lack resources like time. If they are not allowed to be solution builders, a conflict of interest can emerge, and they can become blockers.
- **Initiators** (Matches partially). Can bring attention to problems in the workplace.
- **Change owners** (Matches partially). Have no legitimate ownership of the change but can be assigned to implement the change at their workplace and have the mandate to determine if the system is not safe for the patients and have to be changed.
- **Documenters** (Matches partially). Can take part in both formulating the problem and determining the requirements but have no official role to document the project.

In the discussion the participants agreed that the roles possessed by the nurses depend on the type of nurse. A nurse can function as a manager with a greater area of responsibility, and in those cases, they possess more roles.

Licensed Practical Nurses

- **Subjects** (Matches mostly). Are affected by the change, but more indirectly than the nurses. The nurses delegate assignments to the licensed practical nurses, so if the nurses are convinced the solution is right, the licensed practical nurses are used to being delegated new tasks and new working procedures.
- **Blockers** (Matches mostly). The system can be a threat to a habitual working procedure.

- **Solution builders** (Matches partially). Can contribute to the solution in a similar manner as the nurses, but more indirectly. Have no mandate to determine how the solution should be, but can play an important part in the implementation, e.g. in the patients' homes. They have relevant feedback, since they work directly with the patient.
- **Initiators** (Matches partially). Can bring attention to problems in the workplace.

Doctors

- **Initiators** (Matches fully). Can be on a high level in the hierarchy and have decisiveness and knowledge of the problems. Many doctors and nurses have political influence and can place the problem on the agenda.
- **Subjects** (Matches fully). Uses the system to provide healthcare. Can use the data from the system in their daily work.
- **Solution builders** (Matches mostly). Their needs are important for creating the solution.
- **Convincers** (Matches mostly). Can convince others that the change is needed, but it depends on their placement. Difference in specialist care than home care.

Doctors have more subcategories than the previous actors, which makes it more problematic to define roles. Doctors in leading positions have greater possibility to be initiators and change owners, while doctors working more with patients are more likely to be subjects and solution builders. With this definition, a doctor could technically possess all roles, which could result in conflicts of interest, but if the actor would be defined as a doctor in a specific role the scenario would be different, and the responsibilities could be perhaps be clarified.

Psychologists

- **Subjects** (Matches mostly). The patients want to contact many professionals in the healthcare sector, including psychologists, and VH could be used for this. The psychologists are not relevant if only vital parameters are included, but VH as a communication tool is interesting. The psychologists are important regarding lifestyle improvement. They could also benefit from functions like video calls, forms and other types of follow-up.

Hälsoteknikcentrum Halland (HCH)

- **Solution builders** (Matches fully). Active in the project and contributes to the change and the solution.
- **Documenters** (Matches fully). Documents both the problem formulation and the implementation of the change.

- **Convincers** (Matches fully). Collects statistical material to prove that the change is needed.
- **Initiators** (Matches mostly). HCH was commissioned to initiate the project, without HCH there would not be a prototype today. Brings attention to the project rather than the problem.
- **Change owners** (Matches mostly). HCH, and more specifically the steering committee has formal ownership of the project.
- **Sponsors** (Matches partially). Maintains the legitimacy of the change and manages resources. However, HCHC is not a sponsor itself, but is connected to sponsors like the European Union and the Region.

Treating the organization HCH as one actor results in many roles. One interpretation is that the steering committee at HCH is a change owner and has delegated the task of developing the VH to the employees at HCH. The employees are the ones implementing the change, but they lack the mandate to determine when the change is satisfactory implemented. There is also a connection between solution builders, documenters and convincers, since the solution and the documentation are used to demonstrate that the change is needed

Health Centers

- **Subjects** (Matches fully). The entire operation is affected.
- **Solution builders** (Matches mostly). Need to be involved since their needs and prerequisites are necessary for the project.
- **Blockers** (Matches mostly). All parts must be convinced and involved for the project to come full circle. Lack of time can block.
- **Convincers** (Matches partially). Bring attention to the fact that a change is needed.
- **Change owners** (Matches partially). Are necessary for implementing the change, this can be facilitated if they have some level of ownership.

Business Developers

- **Change owners** (Matches mostly). Have the mandate to determine when the change is implemented. Can help the medical professionals.
- **Convincers** (Matches mostly). It is a part of their role to convince. Want to take part in the project and develop the organization.
- **Initiators** (Matches mostly). Can bring attention to the problem.
- **Solution builders** (Matches mostly). Active in the development of the solution.
- **Documenters** (Matches mostly). Need to document the problems and the requirements of the change.

- **Subjects** (Matches partially). Indirectly affected by what is happening in the operative organization and shall help.

The Business Developer usually runs development projects in parallel with the healthcare and should be deeply rooted in the healthcare. Need mandate from the management but does also have to gain confidence from the rest of the organization to be able to implement the change. Does usually have more time for development than the ordinary medical staff, which is used as a resource.

Head of Units

- **Change owners** (Matches mostly). Applicable for Head of units responsible for Nurses. They have to legitimize the project and are economically responsible for the Nurses.
- **Blockers** (Matches mostly). Applicable for Head of units responsible for Licensed practical nurses. The change can result in big changes for home care, and the Head of unit can determine whether the implementation of the technology should be prioritized.
- **Subjects** (Matches partially). Indirectly affected in their operation.

Steering Committee (HCH)

- **Initiators** (Matches fully). The committee consists of representatives from the Region, the hospitals and the academia. They are responsible for initiating the change.
- **Convincers** (Matches fully). Some members of the Steering Committee are also connected to a Specialist Reception. They use statistics to convince.
- **Change owners** (Matches mostly). Matches partially, have the mandate to determine when change is complete.
- **Sponsors** (Matches mostly). Does not support the project with money, but with legitimacy.
- **Documenters** (Matches mostly). If VH is seen as the main project, the Steering Committee should be responsible for the problem formulation and the requirements that lead to several sub projects.
- **Blockers** (Matches mostly). Could make the decision to change, redirect or delay projects. Could decide to apply for funding for other projects.

The opinions on whether HCH could be seen as a blocker differed. Some participants believed that they could not block a project run by their own organization, while others saw them as different parts of the same organization. The participants also found it logical that they possess more roles, but have less responsibility in each, since they have top down perspective.

Occupational Therapists and Physical Therapists

- **Solution builders** (Matches mostly). If they are involved in the project, they can contribute to the solution.
- **Subjects** (Matches partially). Depend on their involvement. Are subjects if they have to use the service.
- **Blockers** (Matches partially). Risk blocking the change if they are not involved in the project and instructed how it works.

In its current form, VH is more aimed at the part of the healthcare involving Nurses and Doctors and the measurement of vital parameters is in focus. In that case these professions are not directly involved. They are, however, important regarding health promotion and lifestyle improvement, and could be important solution builders if these areas are integrated into the service.

Project economist (HCH)

- **Blocker** (Matches mostly). Can determine if the budget allows certain things or not. If not, it is usually because financial support from a sponsor has ended. Therefore, the Project economist is an actor that connects blockers and change owners.
- **Documenter** (Matches partially). Responsible for economy and bookkeeping, which can be seen as a form of documentation.

Specialist Reception

- **Subjects** (Matches fully). The medical staff will use the system.
- **Solution builders** (Matches mostly). They formulate the requirements on the data measurement needed to create the system.
- **Blockers** (Matches mostly). An initial reaction when the system is implemented could be that the medical staff are afraid to lose their jobs when their tasks are replaced by a digital system. This is inherent in all change projects.
- **Convincers** (Matches mostly). The reception has to act as a convincer toward the patient, to get them to start using VH.
- **Sponsors** (Matches mostly). Applies to the hospital management, that motivates and supports the change.
- **Initiators** (Matches partially). They have found that there is a need for measuring vital parameters at home instead of coming to the hospital.
- **Change owners** (Matches partially). Applies to some doctors, that are in the hospital management and urges the other employees to take part in the change.

This actor is a place, a department, that holds many actors, which is why it matches many roles. The type of role depends on the employee's profession and position.

Roles

Initiators

Many of the actors marked as initiators, mainly the medical staff, *can* bring attention problems and act as initiators, but have not done so in this particular project. They are however, described as being interested in the change and when they hear about the new technology or the planned change in the region, they start to bring attention to it. This creates a form of chain reaction, where many individuals can act as initiators in their organization or at their facility.

Other actors, mainly the steering committee at HCH, are official initiators that have initiated and run the project. The distribution of the green circles in the initiators column in **figure 4.4** indicates that many actors are interested in the change, but that HCH are responsible for that it happens.

Sponsors

There were relatively few actors marked as sponsors. This makes the relationship between these more important, since there are not so many that can take over if one actor would leave the project. HCH is crucial for maintaining the project, and if HCH would prioritize other projects or run out of economic resources the project VH would probably end.

It was also suggested that sponsoring appears to take place stepwise, since the resources come from above and HCH handles and distributes them. In addition, the sponsors seem to vary over time, and their importance seem to vary in between different stages of the project. It is more important that the medical staff maintain the legitimacy at the end of the project, when it is implemented into the healthcare.

Convincers

Based on the actors marked in this category, is was suggested that the convincer could be an academic role in the project VH. This corresponds with the doctors that are researchers and HCH that has a research focus. It seems, however, that both these sides are important as convincers. Without having doctors supporting the project, there would be a risk that evidence would be questioned and that HCH would be seen as pundits.

The process of convincing also appears to take place stepwise, since the medical staff have to be convinced of solution in order to start convincing the patients to use it. It was suggested that there is a difference in convincing others that a change should happen and to convince others that a

system should be used. HCH is the most important convincer for the change, the doctors and the head of units are the most important for getting the medical staff and the patient to use it.

Change owners

A relatively large number of actors where identified in this category. It was however, agreed that some of these actors want the change to happen, but do not have the possibility to implement it on their own. HCH seem to have a unique position with connections to all other actors and has the mandate to determine when the solution is satisfactory implemented, which makes it logical that they are the official owner the project VH. This could also make them a weak spot if time and other resources are missing. Most employees at HCH have several assignments and work with different projects, which could lead to a slower development of the project VH.

In the end all participants agreed that HCH is the main change owner, but at the initial vote the result was mixed. Not everyone marked HCH as this, and it could indicate that it unclear for some actors who is the official change owner. An uncertainty like that could lead to issues regarding responsibility.

Subjects

A majority of the actors were included in this category. It should, however, be noted that they are to be viewed as potential subjects of the change, and that their involvement depends on which areas of treatment are included in VH. E.g. psychologists will become subjects of the change if they would start to use VH for communicating and monitoring their patients. It is important that the actors that become subjects are in agreement with the meaning of the change, and that they accept the solution. If not, they have to be convinced by the convincers or the solution has to be changed by the solution builders. E.g. the doctors are in a position where they can convince the patients of the benefits of using the system, which shows that the actors affect each other in the implementation of the change.

Blockers

The actors can become blockers for many different reasons, e.g. lack of time, money and other resources or that are afraid to lose the job due to the change of work procedures. This results in many potential blockers, but on the other hand no actor matched the role blocker perfectly, and no actor was only marked as blocker. This could indicate that no actor can be only negatively affected by the change, and instead all actors can gain something from the change if it is implemented correctly.

Several actors are marked as both subjects and blockers, which is logical since they will oppose the change if affects them negatively and this is another indication that is important to convince

all the subjects. It was, however, suggested that the blockers that are also primarily subjects have the ability to block the implementation of the solution, but not the system change. It also seems that different actors risk blocking the project at different stages. In addition, the views on which actors where likely to be blockers different among the participants. The medical staff's skepticism against new technology seem to be very different in different places in the healthcare.

Solution builders

This category also contains many actors, but they can contribute to the solution in very different ways. E.g. the medical staff can contribute with feedback and experience, while HCH can contribute with resources and practical action. If more actors are allowed to be solution builders, they can give more knowledge to the project. This can increase the understanding of the different actors' problems and needs, and a more user centered solution can be created. Therefore, it can be positive for the project to have many actors in this category.

Documenters

It was suggested that this role partly coincides with solution builder, but that it has a more administrative focus. The employees at HCH work actively with the project and at the same time document their progression. The steering committee at HCH have a more official obligation to ensure that the project is documented, and they are responsible for that the change meets the requirements. To have many actors for this role could be negative, since a responsibility distributed on several individuals or organizations can result in that no one takes responsibility. There seems to be a need to clarify who should document what, especially within HCH.

Conclusions after CHAI-workshop

The CHAI method revealed few unexpected or surprising properties for the stakeholders. The workshop did, however, produce many valuable insights and discussions, and the populated matrix is a useful visualization of the distribution of responsibility within a complex project like VH. The different sizes of the circles in **figure 4.4** show both in which area a role is represented, and which type of roles an actor possess. This creates different focus areas that can be further analyzed.

The nurses and the doctors have the biggest circles in the subjects' column, which indicates that their involvement should be prioritized in this type of project. The psychologists and the therapists have smaller circles, so they can be involved but are less important. It is also visible that HCH and its steering committee have several large circles, so they have a high responsibility for making the change succeed. In this case, the matrix also shows a difference within HCH. The steering committee has its weight to left with the more the administrative roles, while the rest of HCH has its weight to the right with the more implementing roles.

The matrix shows a relatively high number of subjects, which indicates that the development and implementation of VH on a large scale will affect many people, directly or indirectly. The system can also result in organizational changes when new working procedures are introduced. This means that many different professionals could be involved in the project, but for a project like VH, on a smaller scale relatively early in development, it is more reasonable to focus on the most important professions, the ones that work closest to the patients.

In addition, the possibility to engage more of these subjects early in the development of the interface was limited due to the Covid-19 outbreak. The stakeholder analysis shows, for instance, that patients and doctors can contribute in many ways to the project, but their involvement was not possible in this phase of the project.

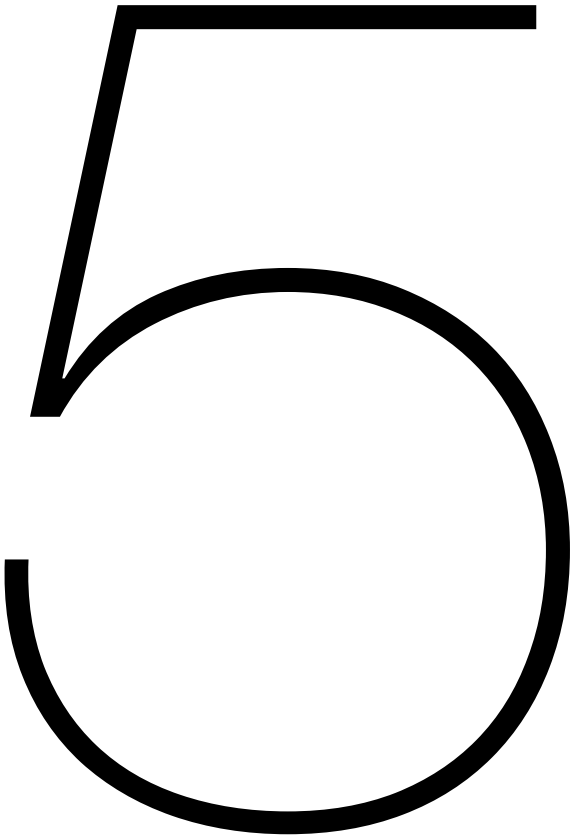
In the matrix the subjects also coincide with solution builders to large extent. It is good that the participants see the subjects as solution builders since it can enable a more user centered solution. They must, however, be actively involved in the process by letting them contribute with feedback and expertise.

Lastly, it is clear that HCH has the leading role in the project VH. The project's development and success are strongly linked to their engagement and prioritization. The fact that HCH is an innovation arena with many of its employees working there part time could make the conditions for projects run there different from projects run in other organizations. It is, for instance, likely that if VH was being developed by a profit driven company, more resources in form of time and money would be invested into the project. In that scenario, however, the connection to healthcare providers and academia would probably be weaker, and the knowledge base less substantiated.

4.5 Conclusion

The Explore phase consisted of two parts, the interviews and the stakeholder analysis, and both have provided useful insights for the development of the digital interface. The result of the CHAI method should, however, be seen as an outcome on its own, and the aim has been that the identification of the stakeholders and the evaluation of the project, as well as the introduction of the new analysis tool, should be useful for the HCH in general. This means that the stakeholder analysis ends here, while the insights regarding the interface are further analyzed in the Define phase. The most important of these insights are presented below.

- Assessment of a patient's health cannot be based entirely on the vital parameters. Self-evaluation tools like CAT and the dialogue with the patient are also important tools.
- If the measured values are presented to the patient, they also have to be presented pedagogically and explained so that the patient knows what do. If not, support should be easily accessible.
- The patient's anxiety is a more important factor for medical applications than in consumer applications. The product should decrease anxiety.
- The IT experience differs greatly between patients. Some are unfamiliar with digital interfaces and taking part of medical data, while others already uses measurement equipment because they are interested.
- Implementation of new digital systems can both decrease and increase workload for the medical staff. The system should decrease the workload instead of increasing it.
- The attitude towards new digital systems differs greatly between medical professionals. Some see the change as a threat or bad prioritization, while others see it as a natural technological development that can help them.



DEFINE

5 Define

5.1 Introduction

In the Define phase the insights from the previous phases were combined to create personas and a list of requirements. The research on COPD, digital healthcare, UX-design and the benchmark in the Background phase provided useful knowledge of how digital services and interfaces for patients with chronic diseases could be designed. In addition, the interviews and the stakeholder analysis in the Explore phase provided in-depth knowledge on the treatment of COPD-patients, the healthcare sector in general and the project VH in particular. This resulted in five personas representing both patients and medical professionals, and a list of requirements for both the overall VH system and the interface designed in this project.

5.2 Aim

The aim of this phase was to define the needs of the patients and the medical professionals and how the system and the interface should meet them.

5.3 Methods

In order to make the qualitative data from the interviews and the workshop in the Explore phase easier to overview and more comprehensible for further development, a list of requirements was created. To take the personal needs and perspective of the patients and medical professionals into consideration, personas was created.

5.3.1 List of requirements

A list of requirements was created based on the insights and evaluation from the CHAI workshop and the interviews. The list of requirements was divided into two parts: one targeting the concept of Virtual Hospital as a service, meaning, what are the requirements for those who are affected by Virtual Hospital, e.g. personals, organization and administration. The second list of requirements is for the user interface and is used as a design guidance for the Create phase. According to Johannesson et al. (2013), a list of requirements is a directorial asset when designing new products. The requirements were marked as demand or desire, based on how big the user need was and how strongly the opinions were expressed. This prioritization was used to indicate how important the fulfillment of a certain requirement was for the development of the user interface. During the development process list of requirements is matched and compared with generated design ideas and concepts to verify if the requirement has been met.

5.3.2 Personas

Based on the result from the requirement lists and insight from the participants in the interviews, it helped us to identify important characteristics for the user group. The results were summarized and described into 5 personas. By collecting data and summarizing it into personas, it is possible to better understand and synthesize user needs (Interaction Design Foundation, 2020). Moreover, we emphasized their experience with technology and attitudes towards technology in general.

5.4 Results

5.4.1 List of requirements

The list of requirements is divided into two parts. The first part of the requirements is listed with emphasis on the user interface (see **table 5.1**) and the second part focusing on the project VH in general (see appendix 11.3).

Table 5.1 - List of requirements for the user interface

	Requirements	Demand	Desire
1	The patient should be able to use the service		
1.1	The UI should explain what the measured values mean for the patient	**x**	
1.2	The UI should adapt to the user base's technical knowledge levels	**x**	
1.3	The system should remind the patient to take measurements		**x**
1.4	The system should explain how the data is shared and utilized	**x**	
2	The system should enable self-care		
2.1	The UI should include self-care advice		**x**
2.2	The UI should encourage healthier habits		**x**
2.3	The system should remind the patient to follow self-care advice		**x**
2.4	The UI should explain use of medical devices for medication		**x**
3	The patient should be able to monitor the disease		
3.1	The UI should show the patient's overall health status	**x**	
3.2	The UI should explain how to interpret the measured values	**x**	
3.3	The UI should offer detailed views of the measured values over time		**x**

3.4	The UI should utilize the measured values to make the patient more engaged		**x**
3.5	The UI should inform the patient about its illness		**x**

4 The healthcare provider should be able to monitor the disease

4.1	The system should make the measured data available for associated healthcare providers	**x**	
4.2	The system should show make CAT data available for associated healthcare providers		**x**

5 The system should facilitate contact between the patient and the healthcare provider

5.1	The UI should provide contact information and when to use it	**x**	
5.2	The system should provide quick access to contact information if exacerbation is detected	**x**	
5.3	The system should enable virtual meetings		**x**

6 The patient should be able to take measurements autonomously

6.1	The UI should explain how to use the measurement equipment	**x**	
6.2	The UI should guide the user through the measurement process	**x**	
6.3	The system should allow the patient to fill in CAT forms		**x**
6.4	The system should ensure measurement is correctly made for the user	**x**	

7 The system should detect divergence

7.1	The UI should alert about potential exacerbations for the patient		**x**

8 The system should improve the healthcare provider's working procedures

8.1	The system needs to convince medical professional the benefits of the system	**x**	
8.2	The system should be working remotely on portable devices		**x**

5.4.2 Personas

It is difficult to identify one single user group based on the results from the interviews, requirements and workshop alone. Therefore, several personas were created based on the inputs. It was summarized and diversified so that no personas could reflect on only one interviewee. Furthermore, comparing the interviews from nurses gave insights about different ambitions and

opinions about the concept that, therefore, influenced all the personas. The five personas were divided into two groups; nurses and patients with COPD. The patients' personas are described with different stages and symptoms with COPD, their mindset and daily habits. The nurses' personas are leaning towards more about current work tasks, and all personas are described with an attitude towards technology, experience with technology and opinions about patient engagement and self-care.

Nurses

Elisabeth

Elisabeth is a middle-age COPD-nurse working at the largest hopsital in Region Halland at the respiratory department. She has worked as a nurse over 30 years and has pursued both a regular nurse education and nurse specialist education. She living in the surburban area in a terraced house with her housband and two edlery kids. When she works with COPD patient she is focusing on getting the overall picture of the patient and their illness. She is determined that the social contact and dialog with patients is much as important as the treatment itself. Hence, she prefers that the talk takes its time and that it is not rushed, so the patients can a sense of comfort and accomplishment that the nurses have taken their time to listen to them. Moreover, thanks to her long-time working experience and work tasks she is doing more than what is asked for her to make it easier for the patient. She sees herself as the one who has the central role for taking care of the patients and the department even has an on-call duty service whenever the patient want to contact them. In terms of increased patient engagement and self-care, she believes that the measured data and the process of measuring might create an opposite effect for the patient and increase the anxiety rather than engaging the patient. Healthcare workers' responsibility is to take care of patients, not the other way around. Although, she knows for a fact that an engaged patient is more treatable than a non-engaged patient. When it comes to attitudes towards technology she is generally doubtful of introducing new systems that affects her work flow, as pilot testing has been carried out over the years with fluctuating success; she usually prefers contacting patients over a voice call on the phone than e.g. videotelephony. Although, the move from paper medical records to digital medical records is a transition that has been successful for her workflow. In regard to experience, Elisabeth has adapted to the smartphone usage and when it comes to new software she prefers that someone guides her through it, since she is impatient with troubleshooting.

Sara

Sara is a young nurse at one of the hospitals in Region Västra Götaland. She is newly graduated as specialist nurse for respiratory practices and has just started working for the department. She had two years of working experience as a regular nurse before she started her specialist education. She is living in a flat near the hospital. The hospital she works at has recently started working more closely with all the different care providers and instances that is involved for a COPD. The intention is to give the patient a better experience and gain more involvement towards the illness. Moreover, as a fresh nurse, Sara is still gaining a lot of working experience and insights every day. She is committed to her work tasks but don't necessarily do more than what is asked for her due to the fact of less experience. Sara appreciates the long talks with patients and the stories about their illness. When it comes to increased self-care and patient engagement, she is aware of the challenges the health care system is facing, although she is curious about the changes and what affects it will have in her work. Moreover, Sara believes that an increased patient engagement will also make it easier for her own work as a nurse to treat the patient. This also includes self-care and that some tasks can be done by the patient themselves, e.g. regular measurements. It will in the end result in an increased quality of health care in general. When it comes to attitudes towards technology, she is a firm believer that technology should enable and not limit the user. Furthermore, she thinks that some of the systems she uses in her work could work more seamlessly and integrated with each other, and that some of the systems has potentials for improvements to reduce the administrative work. In the matter of experience with technology as she is labeled as a millennial, she has more or less grown up with technology and uses it every day. She uses her smartphone for staying in contact with her friends and family through instant messages, mail and social media. Lastly, Sara owns a wearable mostly for tracking her progress when she is exercising.

Patients

Lennart

Lennart is an elderly senior with COPD at stage 3. He previously worked as a house painter but occasionally does work for friends and family. Besides that, he is involved in different organizations for him and his wife to remain active and to have a social life together. He has been diagnosed with COPD for a long time and stopped smoking right after he was diagnosed with the illness. Which makes him confident with his illness, though, as the severeness has increased recently it has started to limit his everyday choices more. Unfortunately, he has less of an appetite and unintentionally started to lose weight. Consequently, this has led to more visits to the hospital for more regular

checks. Due to the fact of increased visits to the hospital, he trusts that he gets the best treatment from the hospital and health care workers and is not enthusiastic about the idea of self-care. Regarding attitudes towards technology, Lennart is less experienced with the technology transition and sometimes feels forced by it when services are adapting to new and "smarter" changes. When he buys new devices, he often feels a frustration when setting up the new device gets too complicated and then he quickly loses interest in the device. Sometimes this experience continues when using the device. Additionally, Lennart can be considered a laggard, someone who adapts slowly to new technologies. Although, he owns a smartphone but doesn't use it to the extent of what is possible. However, he likes staying in contact with family and friends and appreciates taking and sharing photos with it.

Anna-Karin

Anna-Karin is a teacher in elementary school. She is married and lives with her husband and her two teenage children in a suburban city to Gothenburg. She is interested in art and casually paints as a hobby. Moreover, she stays active by doing Nordic walking with friends. However, living with two teenage children is not easy and sometimes household chores take more time than expected. She was recently diagnosed with COPD meaning that she is in an early stage and her symptoms are not so severe. However, she finds the coughing and phlegm alarming. Since the disease is recent, all of what is forthcoming gives her some dread for the future and anxiety. She is aware about the situations and open to all the facts from the health care. One of the first things she quit was her smoking habit and she continued to exercise more regularly to avoid the disease limiting her life. Moreover, when it comes to hospital visits, Anna-Karin appreciates that the healthcare personal takes the time and talk to her and put her in the center of the room. And because everything centers around the disease, she is willing to try new things to make her quality of life better. When she heard about self-care she initially thought is sounded like a great idea and wanted to try it out. Albeit, Anna-Karin is anxious about doing it by herself and the circumstances about getting it right and do something wrong. As she is a person who mostly asks people for help with technology, she turns to her children for help when something is not working. Anna-Karin is still adapted to the new technology and uses a smartphone to share short clips of cats to her friends and family with emojis attached to the messages. She recently purchased an iPad for looking up recipes, paying bills and social media.

Per-Olof “Peo”

Peo is a senior and recently retired from his work as a mining engineer. He lives in the countryside with his wife and has two adult children who moved out long time ago. Peo is a dog person and owns a border collie that needs walks often. Since both he and his wife are retired, they are seeking a calmer life now and aim to travel together around the world. Peo was diagnosed with COPD a few years ago and is in stage 2. Just like the other personas he managed to quit smoking, but still feels a bit of regretful for smoking his whole life. However, the disease has made him more engaged about the effects it has on his quality of life. He visits the hospital regularly, however, it is long time between the visits, which made him invest in his own pulse oximetry device to use privately. It is his own reassurance and he continuously measures the saturation level and pulse rate. His interest in technology also helped him decide on making the investment. So, it was no wonder Peo got excited once he heard about the self-care studies that have been carried out involving technical devices. In terms of technology experience, he is confident when using a computer and is able to troubleshoot to some extent. He uses a smartphone and a smart watch together to track data of his walks, pulse rate etc. He and his wife watch television through video-on-demand services. His latest project is to set up a smart home with smart lamps so he can control lamps and automate them through his phone.

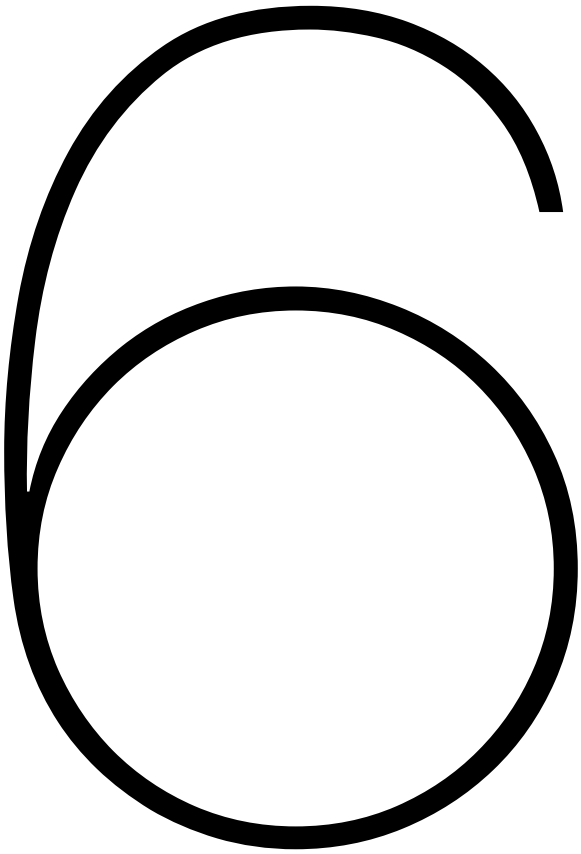
5.5 Conclusion

The Define phase consisted of two parts, defining the requirements for Virtual Hospital and creating personas for better supporting the user group to the final solution, the interface. This phase lays the basis for the creation of the user interface. The most important of these insights are presented below.

- A list of requirements was created to map features that should be included for the Virtual Hospital. Eight areas were found which were graded by demand or desire. The list was funneled into a more thorough part focusing only on the user interface’s requirements.

- Five personas were created to describe the user group for the interface. Divided into nurses and patients with COPD as user groups.

- The nurse personas were described regarding their experience taking care of patients with COPD and their technology experience at work. The patients were described with their experience regarding COPD and their general technology experience.



CREATE

6 Create

6.1 Introduction

In the Create phase a wireframe version of the application was developed based on the list of requirements, the personas and the benchmark. The phase included the creative process of designing the layout, structure and navigation of the interface. Due to the Coronavirus, the possibilities of testing concepts with real users and iterating were low, and it was decided that an interface should be developed to suit HCH's needs based on the knowledge gained up until this point.

6.2 Aim

The aim of this phase was to build a wireframe version of the application that could be used for proof of concept and demonstration of the functionality of VH in HINT. The aim was also to create an interactive application so that the usability could be tested and evaluated in further development.

6.3 Methods

To quickly visualize and work with the structure and navigation of the interface, a user interface flow chart was used. Ideas for the design of the pages in the interface was generated in brainstorming sessions, to allow creative solutions for presenting information and visualizing medical data. Lastly, prototyping software was used to create an interactive wireframe so that the application could be demonstrated and tested.

6.3.1 User interface flow chart

The basics of the interface was designed and visualized with a user interface flow chart. A user interface flow chart is an effective way to visualize which pages are to be included in an interface, how they are connected and how the navigation between them is supposed to work. (Seilevel, 2020). A simple example of this is seen in **figure 6.1**. The flow chart focuses on how the user navigates between the pages and what functions they include, rather than the layout of the interface elements on each page. The process was iterative, and the views were refined and rearranged until a layout that reflected the logical connections between the functions and their level of importance for VH was found.

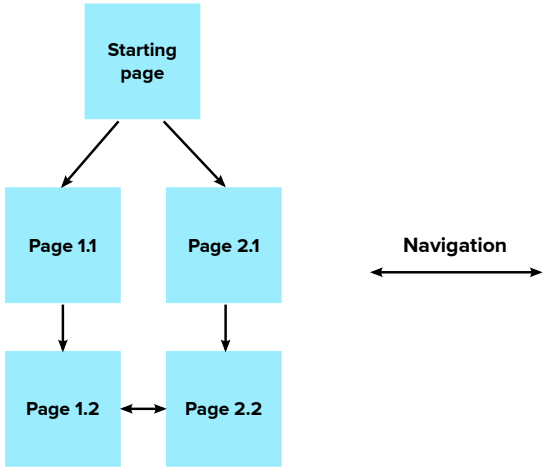


Figure 6.1 - User interface flow chart

6.3.2 Ideation

Based on the pages specified in the interface user flow chart, ideas for the design of these were generated. Ideas for the interaction and the navigation between the pages were also created. This was done in two brainstorming sessions in which the ideas were sketched on paper to allow fast and collaborative ideation. In addition, this ideation continued throughout the next step, the building of the wireframe, to quickly test and discuss ideas and solutions when new pages had to be added.

6.3.3 Wireframe

From the sketches an interactive wireframe version of the interface was built. Sánchez Ramón et al. (2013) describe wireframing as a visual guide used to suggest the contents and structure of the views, and the relationships between them. The method can be used to refine the interface and discuss it with clients and users. The wireframe can be built in different types of software, but some tools made specifically for this can generate a clickable and interactive version of the interface that can be used for user testing.

In this project the user experience design software Adobe XD was used. In the software the pages in the interface are created with text, images, and other graphical elements. Buttons, toggles, sliders and other interactive elements can be connected to different functions such as transitions to other pages or hiding or showing certain elements. The wireframe model can then be exported to a phone or a tablet where it can be used for user testing and evaluation. In order to create an accurate and professional looking solution Apple Human Interface Guidelines was used. Apple offer a wide resources and guidelines for developers to use when developing an app for one of their products. Examples of assets that was offered: UI Kits, typefaces and templates (Apple, 2020).

6.4 Results

6.4.1 User interface flow chart

The tree structure was created based on the insights from the previous phases. In this step 4 major factors were considered:

- The functions desired by the medical professionals and HCH
- Conventional interface structures in consumer applications found in the benchmark
- UX design guidelines for navigation
- The patients' varying IT experience

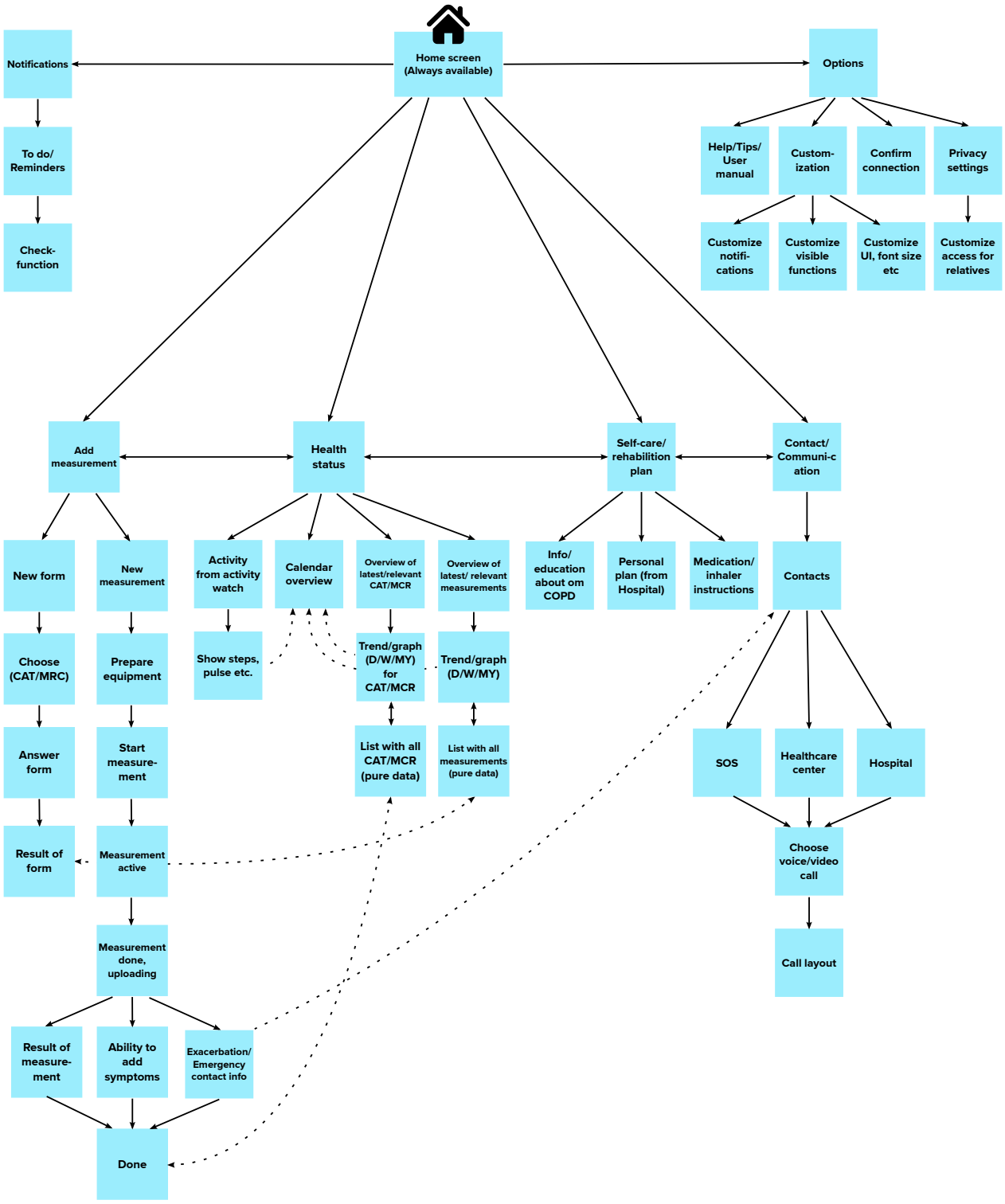


Figure 6.2 - User interface flow chart of the application

The interface tree structure can be seen in **figure 6.2**. The starting view in the interface is a home screen, were 6 buttons lead to pages with the main groups of functions. *Home screen*, *add measurement*, *health status*, *rehabilitation plan* and *contacts* are always reachable with one tap

inside the application, since they have been identified as important functions that should be easily accessible. This is illustrated with the horizontal arrows between these. *Options* and *Notifications* are only available from the *Home screen*, due to their lower intended usage frequency and similar layouts in existing consumer applications. The dotted arrows indicate shortcuts between the different types of functions. For instance, the results of all previous measurements are accessible directly with a button when measurement is done.

6.4.2 Ideation

A selection of the sketches from the ideation process can be seen in **figure 6.3**. In this process, the aim was to create layouts and interactions that made the desired functions found in the Explore phase accessible to the user in an effective and appealing way. At the same time, insights of conventional layouts in consumer applications that were found in the benchmark were used as inspiration, to create pages that appear familiar to the user.

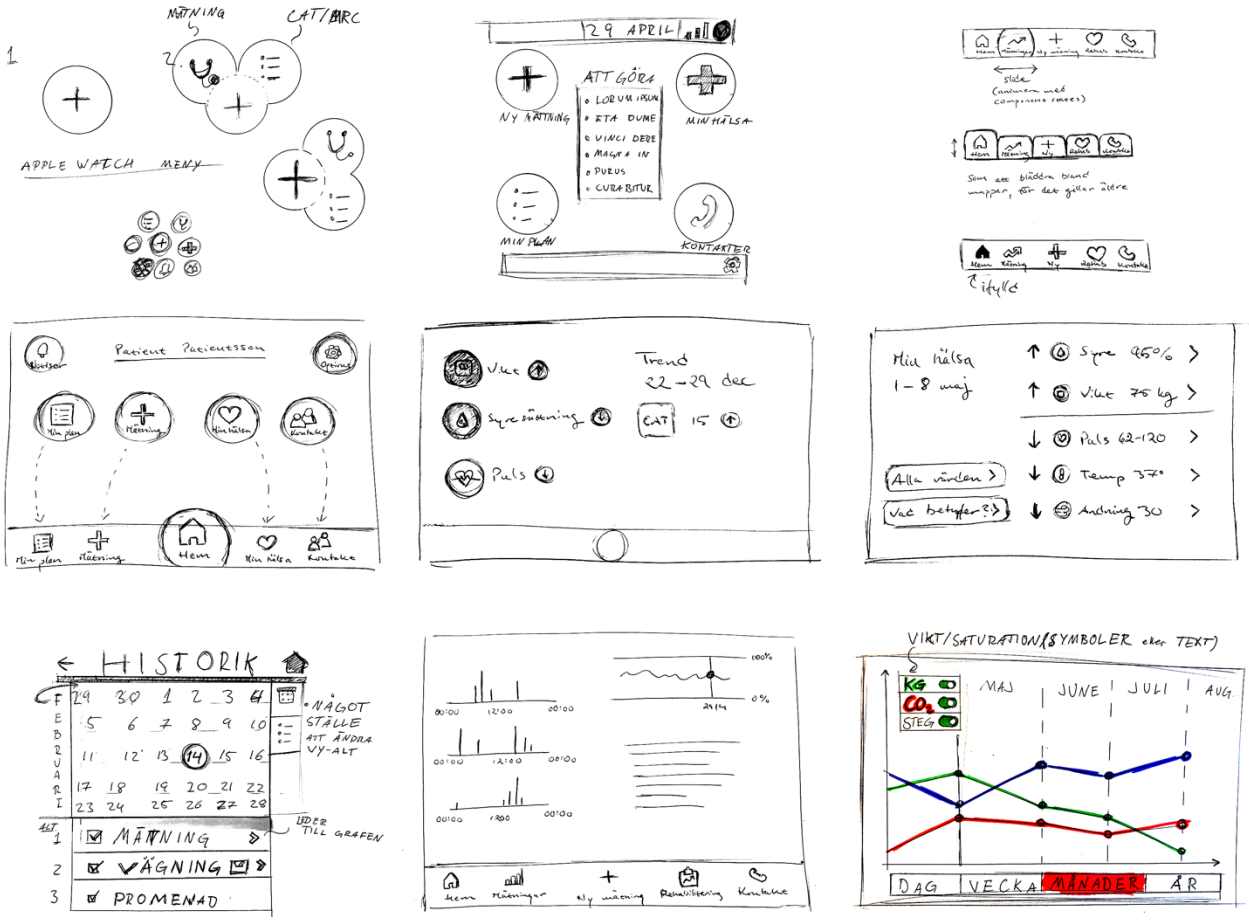


Figure 6.3 - Sketches of ideas for the interface

6.4.3 Wireframe

An overview of the wireframe as seen in Adobe XD can be seen in **figure 6.4** with the gray arrows indicating connections between the pages. In this view, the top level of the interface, with the *home screen* and the six main pages are shown.

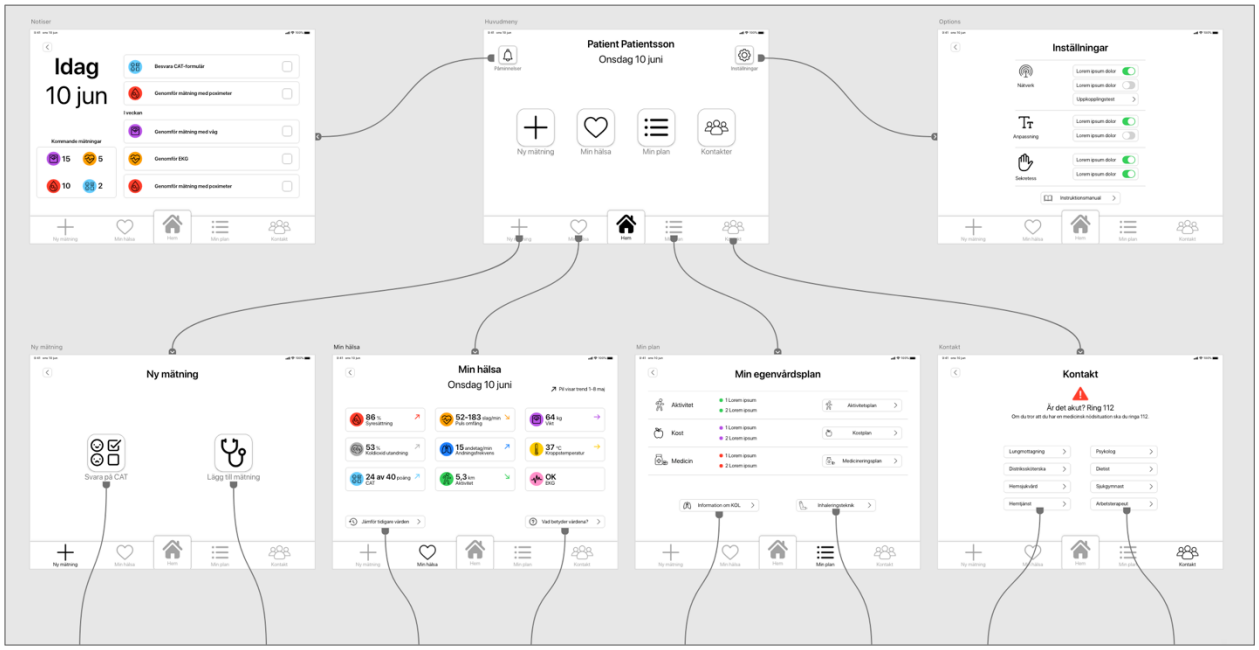


Figure 6.4 - Overview of the wireframe in Adobe XD

Apart from creating the visual appearance for the interface, Adobe XD was used to simulate the behavior of a fully developed consumer application. To achieve this, commonly frequently occurring interactive elements were used, as seen in **figure 6.5**. In this way, the look and behavior of the wireframe became more like existing consumer applications. This facilitated user experience and usability testing, since the user could interact with the application more like they would do with a released product.

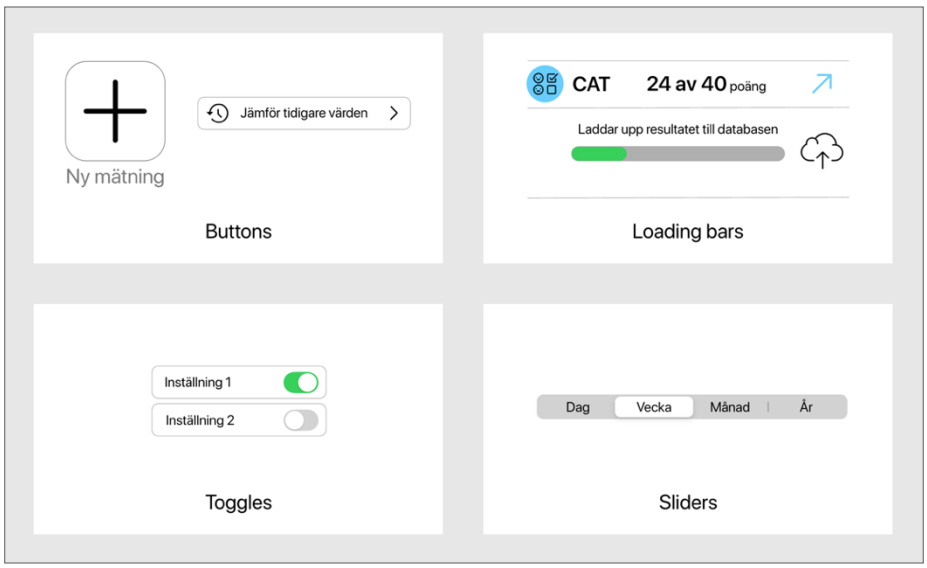


Figure 6.5 - Elements used to create interactions in Adobe XD

6.5 Conclusion

After an iterative process of sketching and testing ideas for layouts and navigation, an interactive wireframe was created. This version of the application fulfills the two purposes: to be able to demonstrate the functionality of the VH in HINT, and to test the usability of the application for further development. In the next chapter, the final concept in this project that is used for both demonstration in HINT and usability testing, is presented.

7

FINAL CONCEPT

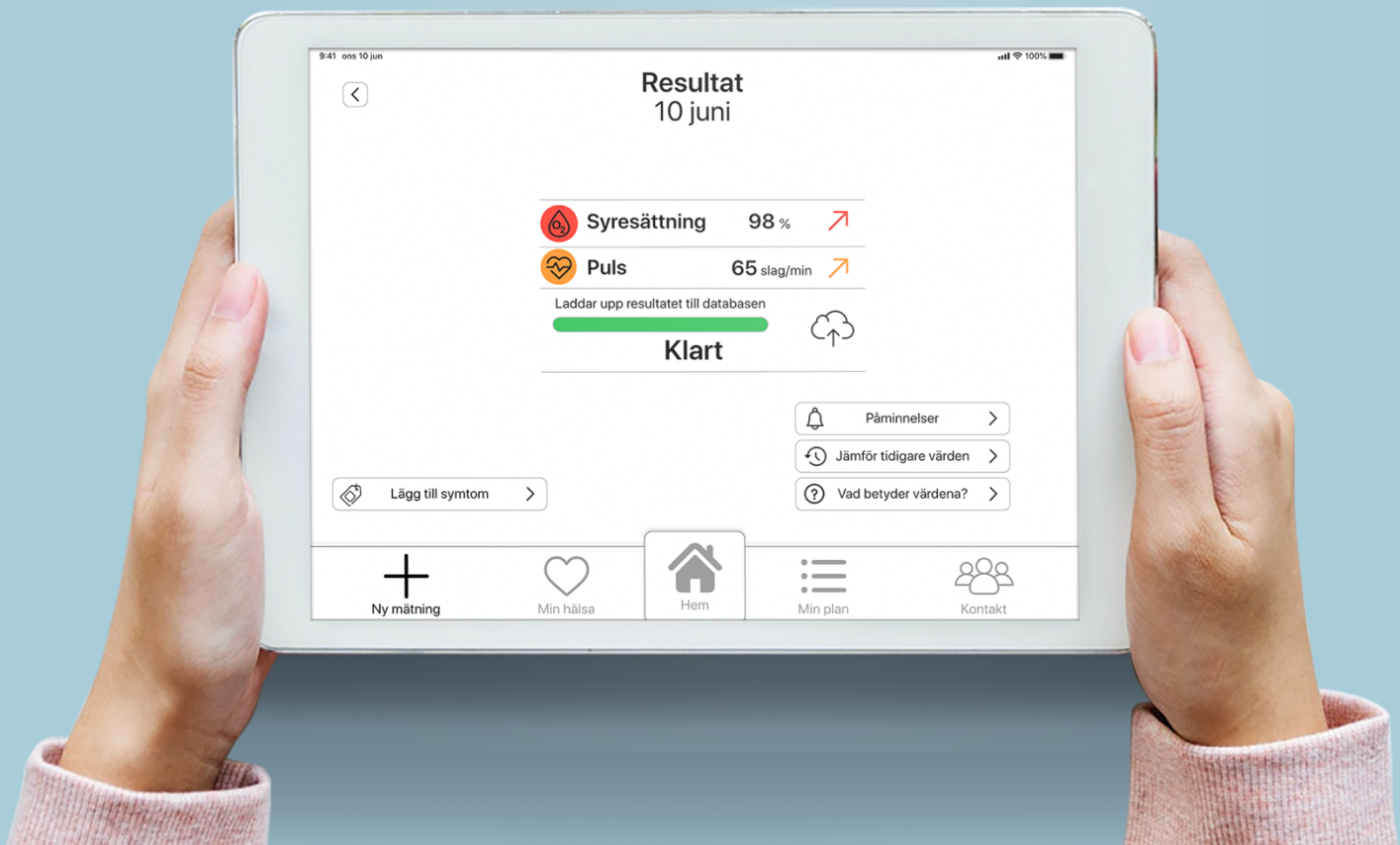

9:41 ons 10 jun
Min hälsa
Onsdag 10 juni
Pil visar trend 1–8 maj
86 % Syresättning
52-183 slag/min Puls omfång
64 kg Vikt
37 °C Kroppstemperatur
15 andetag/min Andningsfrekvens
53 % Koldioxid utandning
OK EKG
5,3 km Aktivitet
24 av 40 poäng CAT
Vad betyder värdena?
Jämför tidigare värden
Hem
Min plan
Kontakt
Min hälsa
Ny mätning

Virtual Hospital

The Virtual Hospital is the link between the patient and the hospital. With the Virtual Hospital application patients with chronic diseases can gain control over their health and their treatment process from their own home. The application guides the patient through the routine of measuring vital parameters and filling out assessment forms, and the data can be easily overviewed. If questions arise, the application provides quick contact with medical professionals for health advice and follow ups. In this way, the Virtual Hospital can facilitate self-care and enhance the patient's quality of life.


9:41 ons 10 jun
100%
Patient Patientsson
Onsdag 10 juni
Påminnelser
Inställningar
Ny mätning
Min hälsa
Min plan
Kontakter
Ny mätning
Min hälsa
Hem
Min plan
Kontakt
Val av mätning
Puls
Vikt
Syresättning
Mäter...

The measurement process



Data and trends

Video call interface

7.1 Usability

Based on the UX design guidelines presented in section 3.3.2, the application has been designed to enhance usability for elderly. The use of a tablet allows for large screen elements and interaction areas than can increase visibility. The font size in the entire application has been increased compared to standard consumer applications for tablets, and a high color contrast between background and text has been used where applicable. An *Options* category has been included in which this could be made customizable to adapt to personal needs.

To make interaction with the application easier, large buttons have been used, and no scrolling or other gestures are required. To facilitate understanding the application, text and icons are always used in combination. This allows the user to read what the icons mean when they start using the application, and then gradually learn the meaning of them so that navigation becomes easier.

In addition, common interaction elements in consumer applications have been used to make the user interface recognizable and familiar. This includes a bottom menu, a home button, date sliders, toggles and buttons for forward and back. The icons that are used have also been selected to match commonly used symbols, to increase understandability. Colors have been used to make different values more distinguishable and to create a more visually pleasing appearance. The use of the colors is, however, not tied to the functions in the interface, and the selection of colors should be seen as a suggestion.

7.2 Functions

7.2.1 Home screen

When starting the application, the user is presented with the *Home screen*, see **figure 7.1**. At the center of the page, four large buttons provide access to the four main functions: *Add measurement*, *My health*, *My plan* and *Contacts*. These are the types of functions that were identified as most important for the patient in the Explore phase. The bottom menu is always visible in the application, and it is used to provide easy navigation between the views. The use of a bottom menu can make the navigation feel familiar to many users, since it is a commonly used interaction element in consumer applications. To provide easy exit from all pages in the application, the button with house icon that leads back to the *Home screen* is enlarged and always visible. To achieve consistency, names and icons for the four main functions are the same in button menu as in the center of the page. In the top corners of the page, buttons for *Reminders* and *Options* are found. These two buttons are smaller and only available from the *Home screen*, due to a lower intended use frequency.

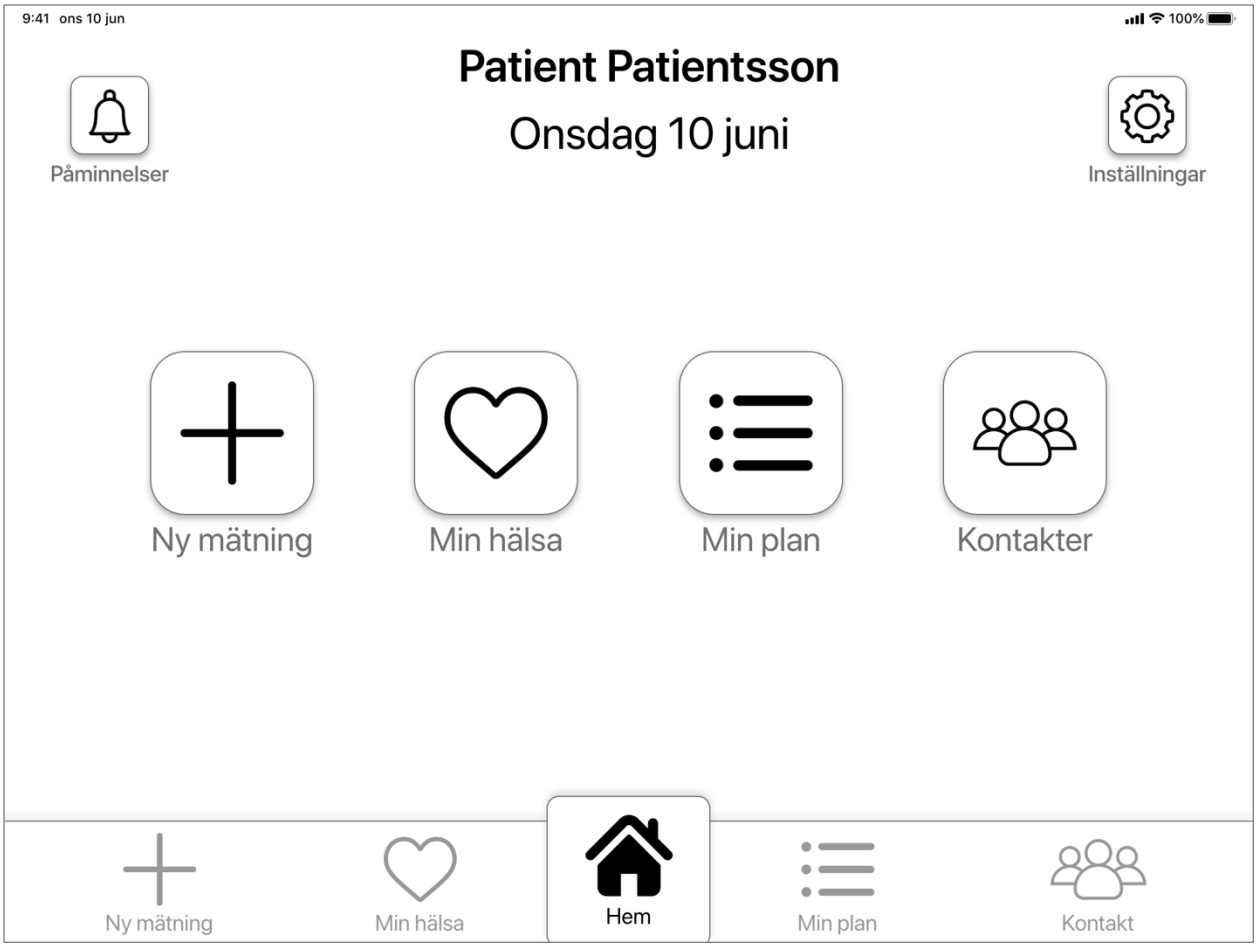


Figure 7.1 - The Home screen

7.2.2 New measurement

The interface guides the patient through the measurement process with the steps seen in **figures 7.2a - 7.2d**. First the patient selects the type of value that should be measured, as seen in **figure 7.2a**. In this version, three values have been used as example, but this could be adapted to the values relevant for the disease in question and the equipment available. **Figure 7.2b** shows how an animation instructs the patient how to use the measurement equipment. During measurement, a loading bar visualizes the process, as seen in **figure 7.2c**. Then the UI in **figure 7.2d** shows that measurement is complete and has been uploaded, and the patient can see the measured value and the trend for that value. In this stage, buttons for *Reminders*, *Compare previous values*, *What do the values mean?* and *Add symptoms* becomes available.

Figure 7.2a - Select type of measurement

Figure 7.2b - Prepare equipment

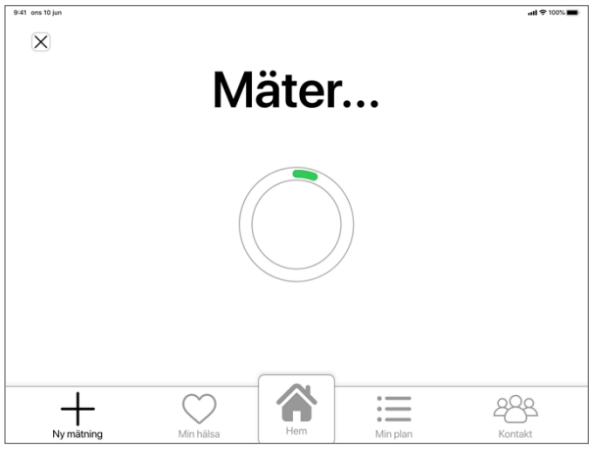


Figure 7.2c - Measuring

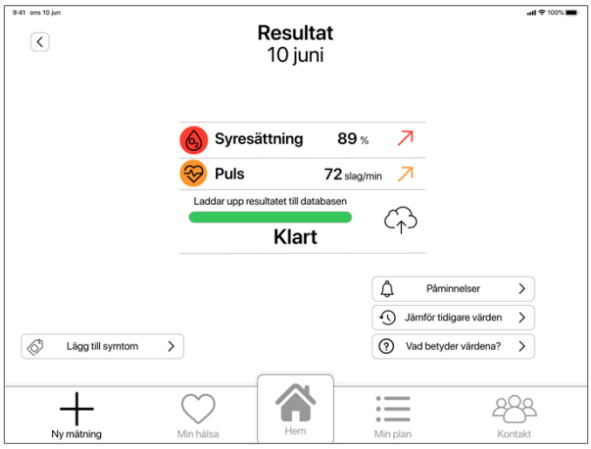


Figure 7.2d - Result of measurement

7.2.3 New CAT form

The user is guided through the process of filling out a CAT for with the steps seen in **figures 7.3a - 7.3c**. The page in **figure 7.3a** lets the patient select CAT or measurement, and the page in **figure 7.3b** lets the patient fill out their experienced health status in the CAT form. Lastly the result and trend are shown as seen in **figure 7.3c**.

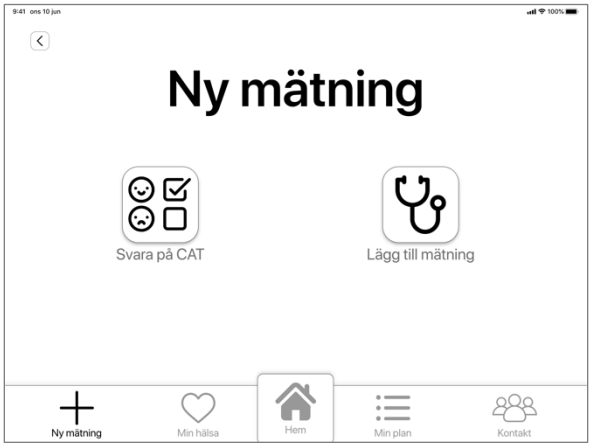


Figure 7.3a - Select CAT or measurement

Figure 7.3b - Answer CAT form

Figure 7.3c - Result of CAT form

7.2.4 My health

The page *My health*, seen in **figure 7.4**, gives the patient an overview of their health status. Text, symbols and colors have been combined to make the values more distinguishable. The most recent values are shown together with an arrow in the same color as the value to indicate if that value is going up or down. The aim with this page is to allow the patient to easily monitor their own values and discuss them with others if needed.

This page does not include indication of which values are good or bad for the patient, but instead they are given the plain value and the trend arrow, so that they can make their own conclusion. To enable this the information under *What do the values mean* is available, and if further guidance is needed, a medical professional can be contacted from *Contacts*. There are two reasons for this: firstly, in most cases a value is not either good or bad, instead it depends on the situation. Secondly, the aim is to make the patient engaged, and teaching them to interpret their own values rather than telling them what is good or bad is one way of doing this.

The values used in this version is the same values used in the existing version in HINT to make them comparable, but *My health* is supposed to be customizable depending on the disease and which values are relevant. These are the values used in this version, from top left to right bottom, row by row:

- Oxygen saturation in the blood
- Pulse range
- Weight
- Carbon dioxide saturation of expired air
- Respiratory rate
- Body temperature
- CAT form result
- Activity
- Electrocardiogram (ECG)

Figure 7.4 - My health

7.2.5 Trends

If the patient wants a more detailed view of a certain value, the *Trends* page, seen in **figure 7.5**, is accessed by pressing the values in *My health*. This view is aimed at patients that are more interested in the data, and all measured values for a certain day, week, month or year can be selected. For some values, like Pulse in this example, different categories like Resting Pulse and Max Pulse are shown to provide even more information.

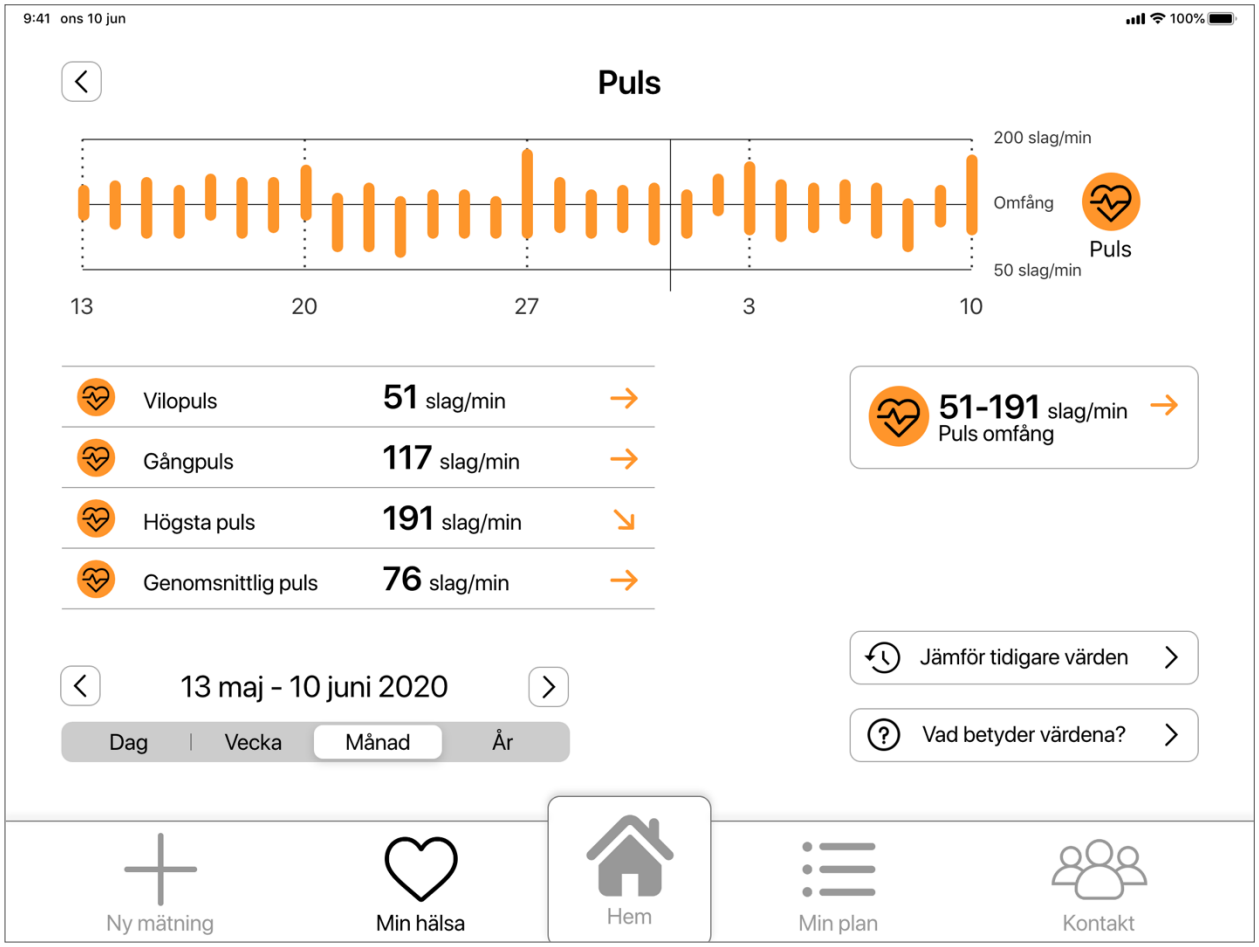


Figure 7.5 - Trends

7.2.6 Compare previous values

The *Compare previous values* page, seen in **figure 7.6** lets the patient compare s selection of values for a certain time period. This allows the patient or an assisting medical professional to see if some values seem connected and if patterns can be detected. In this version three values have been used as example. The values are, from top to bottom:

- Oxygen saturation in the blood
- Pulse range
- Weight

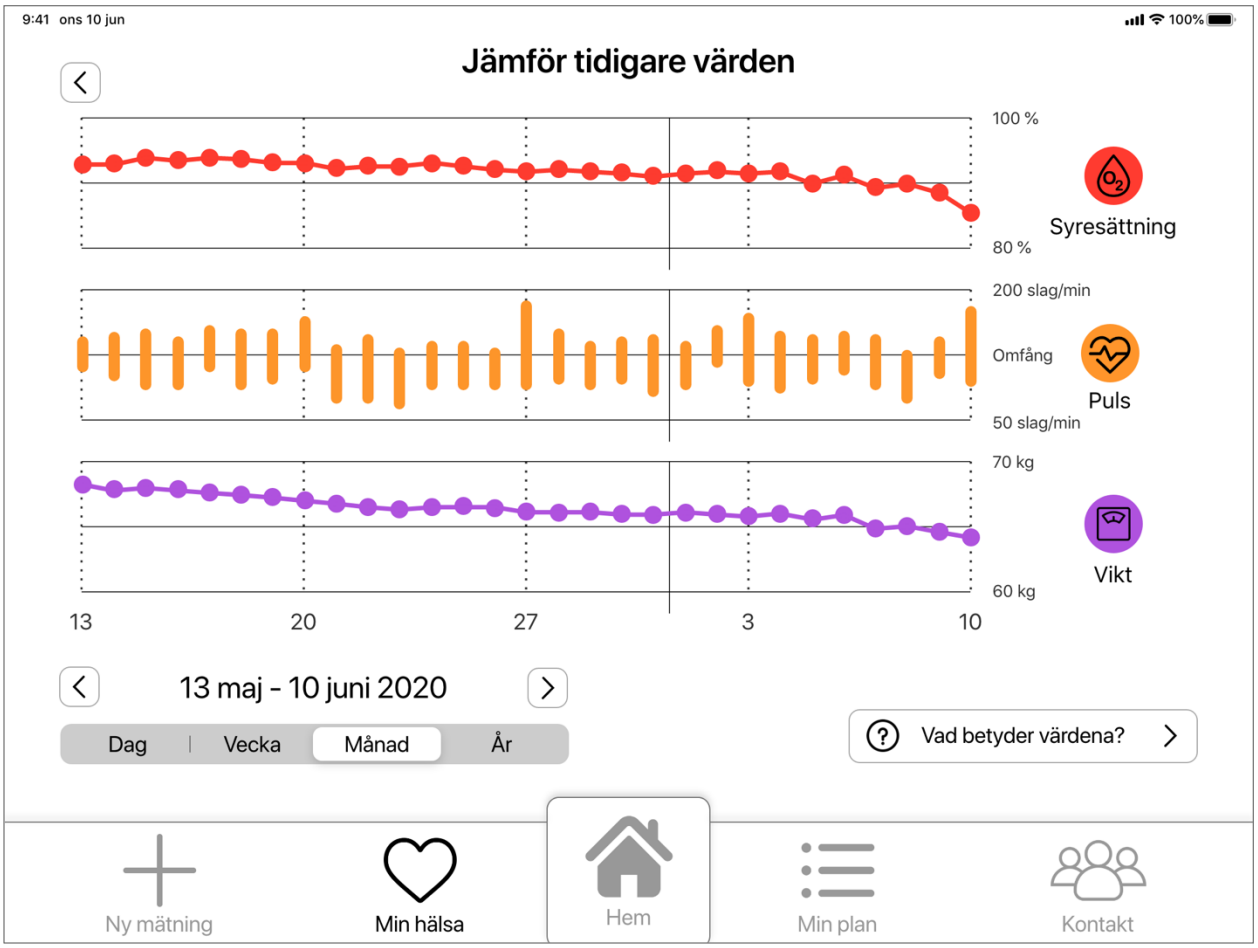


Figure 7.6 - Compare previous values

7.2.7 My plan

The pages under *My plan*, seen in **figures 7.7a - 7.7d**, should facilitate self-care for the patient. Here the self-care plan is found, containing an activity plan, a diet plan, a medication plan, and the latter is shown as an example. In addition, information about COPD and inhaler instructions is included here.

Figure 7.7a - My self-care plan

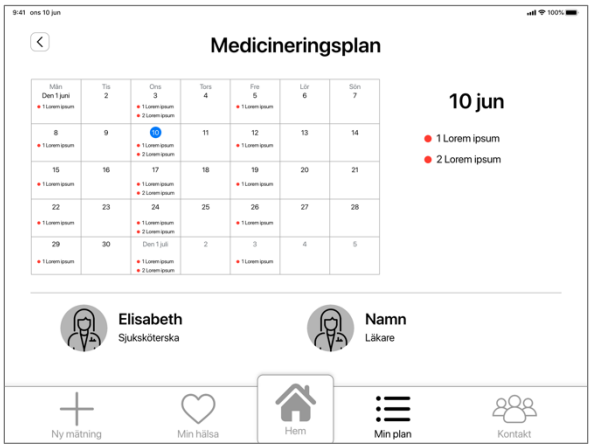


Figure 7.7b - Medication plan

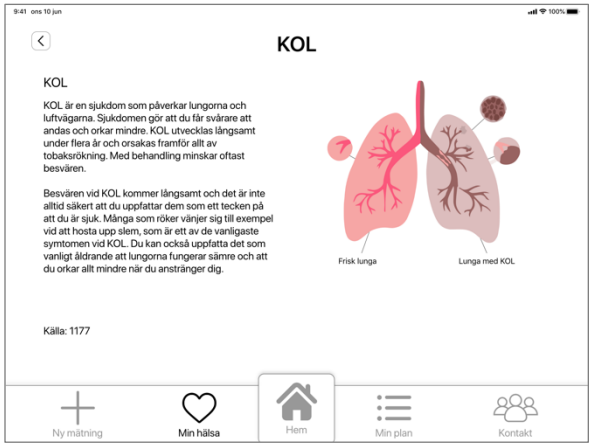


Figure 7.7c - Information about COPD

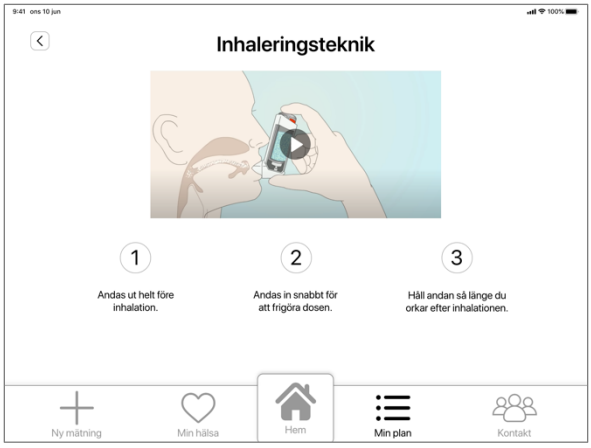


Figure 7.7d - Inhaler technique

7.2.8 Contact

The pages under *Contact*, seen in **figures 7.8a - 7.8c**, lets the patient contact different healthcare facilities and involved medical professionals. **Figure 7.8a** shows a contact list and **figure 7.8b** shows the phone number, call hours and address of a contact. **Figure 7.8c** shows a call page, where a standard video call layout is combined with the patient's values and trends. When the call is active, the idea is that the medical professional on the other end should be able to see the same values and trends, so that they can discuss them with the patient.

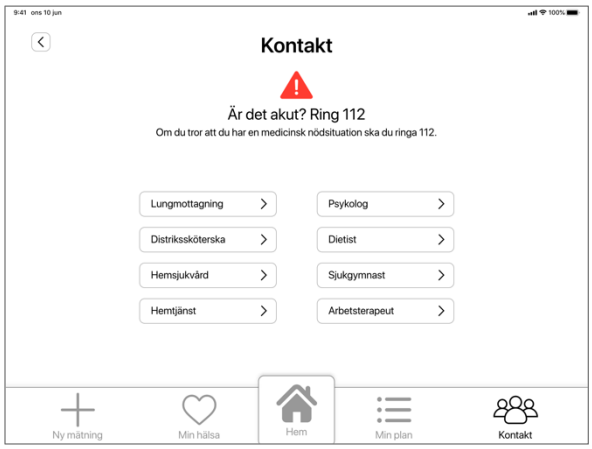


Figure 7.8a - Contact

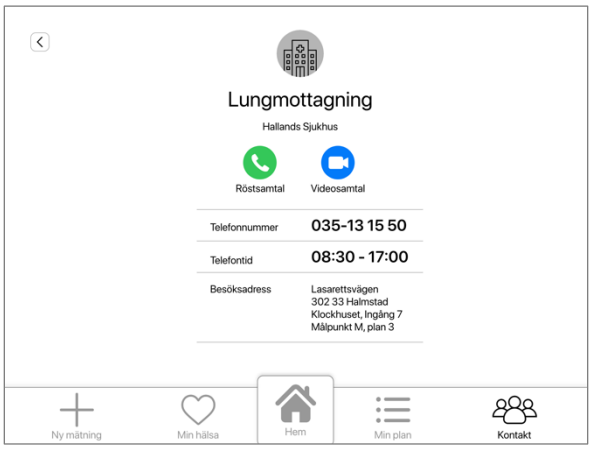


Figure 7.8b - Select voice or video call

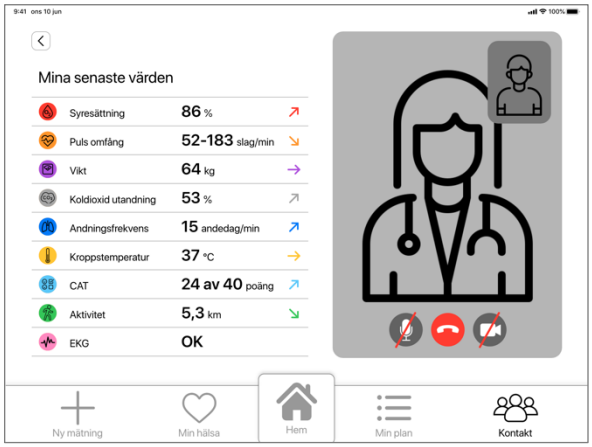


Figure 7.8c - Call active

7.2.9 Reminders

On the *Reminders* page, seen in **figure 7.9**, the patient can see the daily measurements that should be made, and the upcoming tasks. The patient can mark the tasks as done by tapping the checkbox.

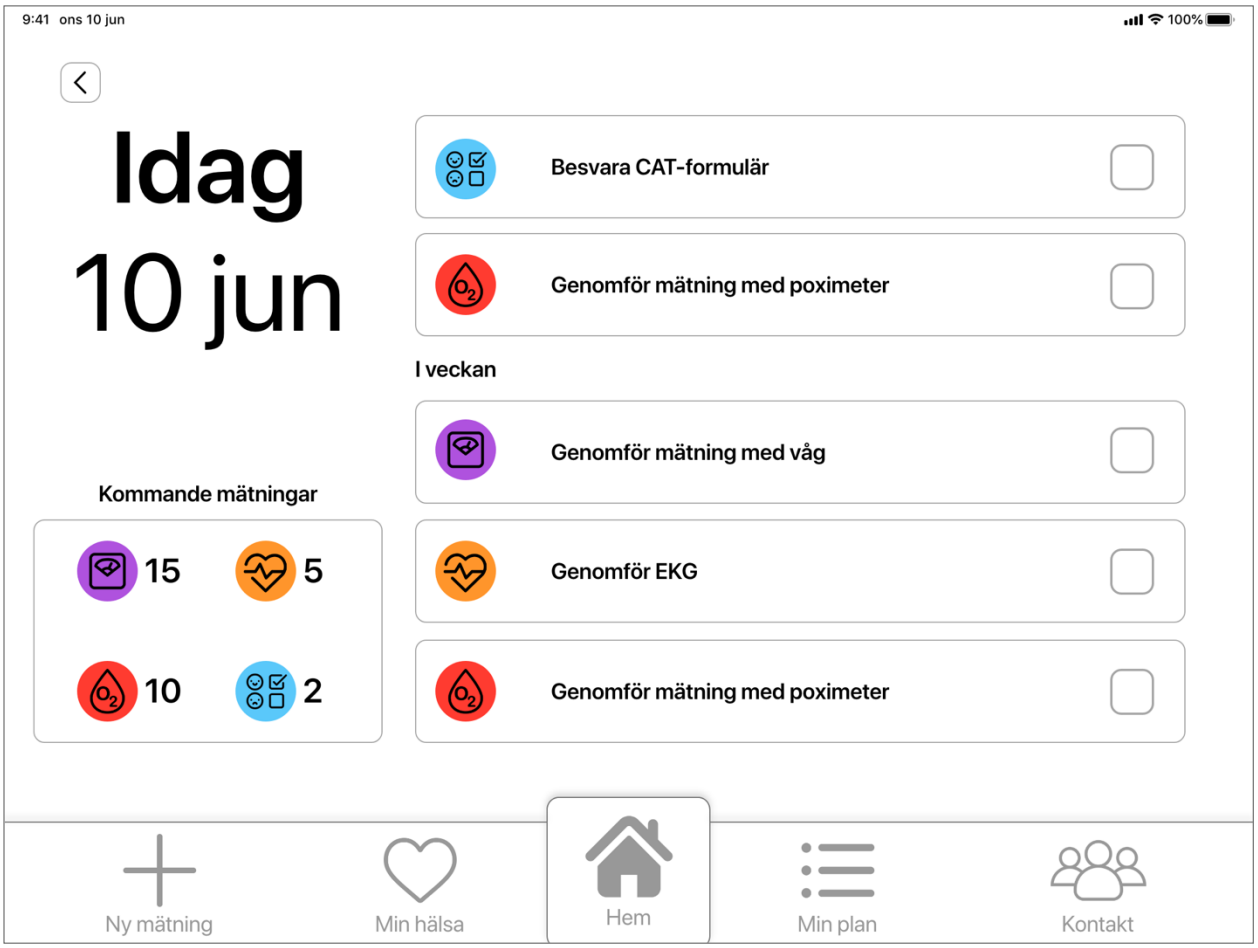


Figure 7.9 - Reminders

7.2.10 Options

In the *Options* page, seen in **figure 7.10**, the patient can customize the appearance and behavior of the interface in different ways. The Latin words "Lorem ipsum dolor" are used as placeholder text, since further research has to define which options are needed. A user manual is also accessible from this page.

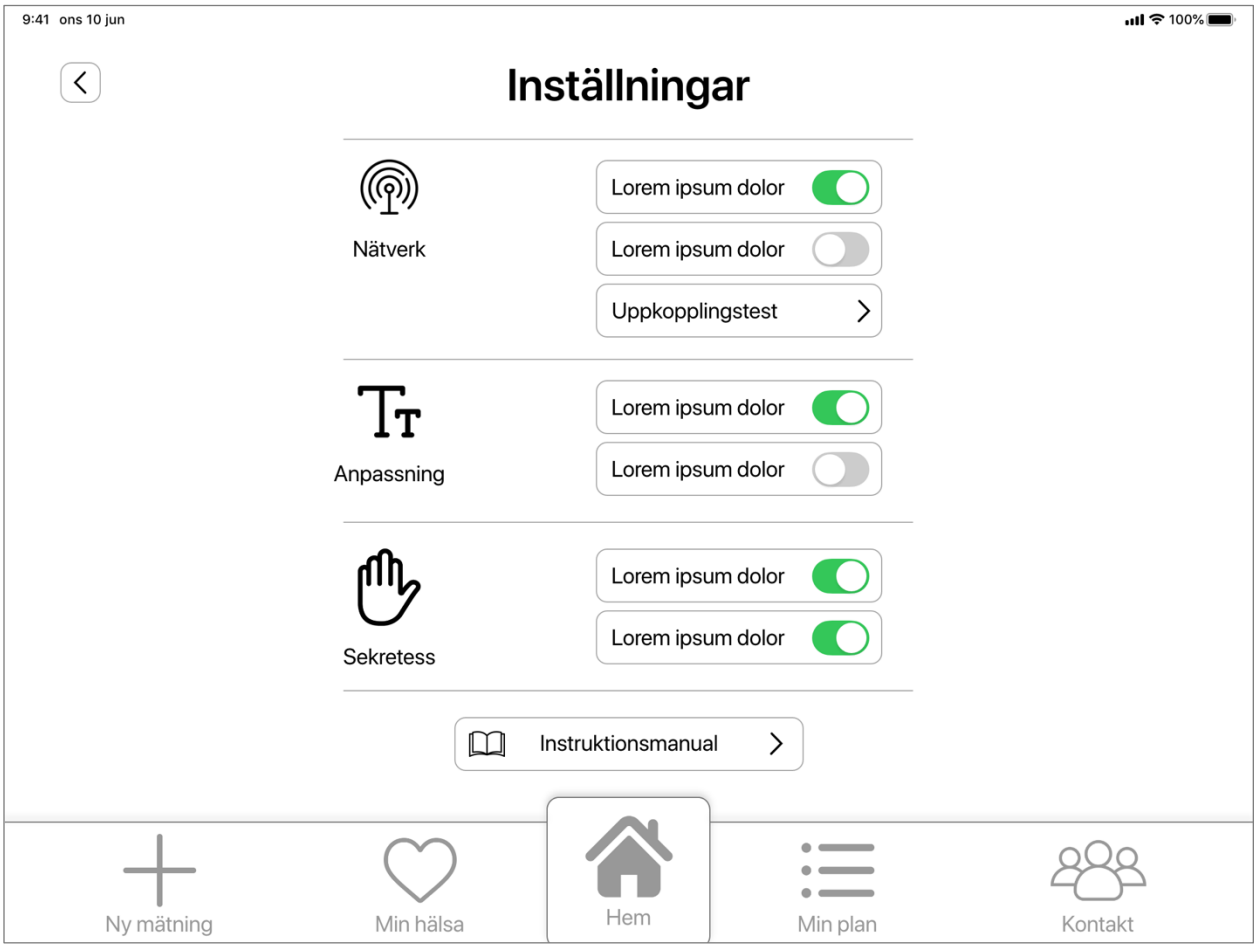


Figure 7.10 - Options

8

EVALUATION

8 Evaluation

8.1 Introduction

In this phase the final concept was evaluated. During this phase, Swedish society was still heavily affected by the Coronavirus with many closed facilities, canceled events and recommendations to avoid all unnecessary contact. Despite this, a group of people from the Swedish Heart and Lung Association wanted to contribute to the project and they agreed to participate in a user test. This possibility appeared relatively late in the project, but user tests are an important part of the design process and can bring valuable insights and improvement proposals. Therefore, a small user test with three patients with chronic diseases was arranged. To reduce the risk of spreading the virus at this occasion, the user was placed with the tablet at a table more than 2 meters away from the interviewers, and the tablet was disinfected between the user tests.

8.2 Aim

The aim of this phase was to briefly evaluate the usability and user experience of the interface to create a basis for further development. The aim was also to evaluate how well the solution answered to the needs from the Define phase.

8.3 Methods

As mentioned in the introduction, the evaluation appeared late in the process due to the restrictions that were affected by the Coronavirus. Therefore, it was necessary to find an arrangement with methods that was comprehensible for the test users, because of high age and limited experience with technology, and still efficient and credible enough to evaluate the result of the project. Furthermore, two methods were chosen for the evaluation test: the first one is Guerilla testing. The method focuses on usability and finding interaction errors between the user and the application. The Geneva Emotion Wheel was the second method for evaluating the subjective feelings regarding the Virtual Hospital as a concept and not the user interface per se. The evaluations were conducted with three participants. Initially six were interested in participating but three of them canceled at the last minute due to worries about coronavirus. Lastly, the wireframe was evaluated versus the requirement list and the personas, to see how well it answered to the needs specified in the Define phase.

8.3.1 Guerilla usability testing

Guerilla usability testing is a way to determine how effective an interface is by checking and capturing its functionality, visual design, and main point to its intended audience (Aspen, 2016).

Compared to conventional usability testing, guerilla usability testing has a more informal and effective approach. Due to the time restriction, the users are given less background information and the session is usually shorter. Moreover, Aspen (2016) explains that it is a low-cost method that is quick and easy to perform, meaning that the users perceive it as manageable and not troublesome to take part. The participants are asked and directed to perform predetermined tasks, and their actions and reactions are noted. In other words, Guerilla testing can be seen as a qualitive testing as the method inclines “why?” rather than quantitative, e.g. “how many?” or “how much?”. The purpose of doing Guerilla testing is not to prove the intended design – instead it is a matter of identifying usability errors and improving the design (Aspen, 2016).

Three patients participated in the test. The patients suffered from different combinations of chronic diseases, including COPD, asthma and heart attack, and were of the ages 65 to 87. Before the individual tests, the users were given an introduction to digital healthcare, the idea behind the Virtual Hospital and this project in particular. In the test, the user was presented to the interactive wireframe on a tablet and asked to try it and tap some buttons to see how it worked. Then the user was given seven tasks:

1. Answer CAT questionnaire
2. Make a pulse oximetry test
3. Check reminders for performed tests
4. Look up monthly resting heart rate
5. Access the self-care plan
6. Look up information about COPD and inhalation
7. Contact the respiratory department at Halmstad hospital

For all users and tasks, the level of success was noted. However, to avoid explaining and assisting during the test, the test leaders did not interfere unless asked. In addition, the users' interactions in the application was recorded as a video on the tablet, and the conversation was recorded as audio, so that the result could be further analyzed after the test.

8.3.2 Pain points

Based on the user test, pain points in the interface were identified, meaning recurring problems that create inconvenience or annoys the user. Certain steps in a task were marked as a pain point if the user found it hard or impossible to solve the task, if the user misinterpreted important information or if the user appeared skeptical. A simple example of a pain point marked with red is shown in **figure 8.1.**

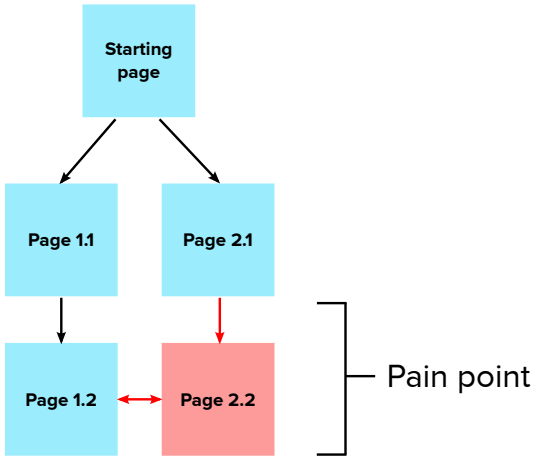


Figure 8.1 - User interface flow chart with pain point marked with red

8.3.3 Geneva Emotion Wheel

Emotions are an integral part when people and objects (e.g. consumer products) are interacting. Therefore, measuring emotional reactions is important when trying to understand how these interactions can be enhanced, e.g. when developing successful user experiences.

The Geneva Emotion Wheel includes a list of distinct emotional words that are consistent to emotion relations arranged in a wheel shape. Within each emotion word there is a grading scale indicating the intensity of the emotion. Furthermore, the wheel consists of two axes, creating quadrants around the circle. The axes are divided into two dimensions; valence (negative to positive) and control (low to high). Valence can best be described as a term about pleasant feelings towards a product, event or situation, ranging from unpleasant (negative) to pleasant (positive).

The user interface solution represents only a small portion of the whole concept, in addition to that the user interface is not fully functional or in a finalized state. Therefore, the Virtual Hospital as a concept was evaluated to better understand the test users' subjective attitude towards the whole concept. An empty template can be seen in **figure 8.2**.

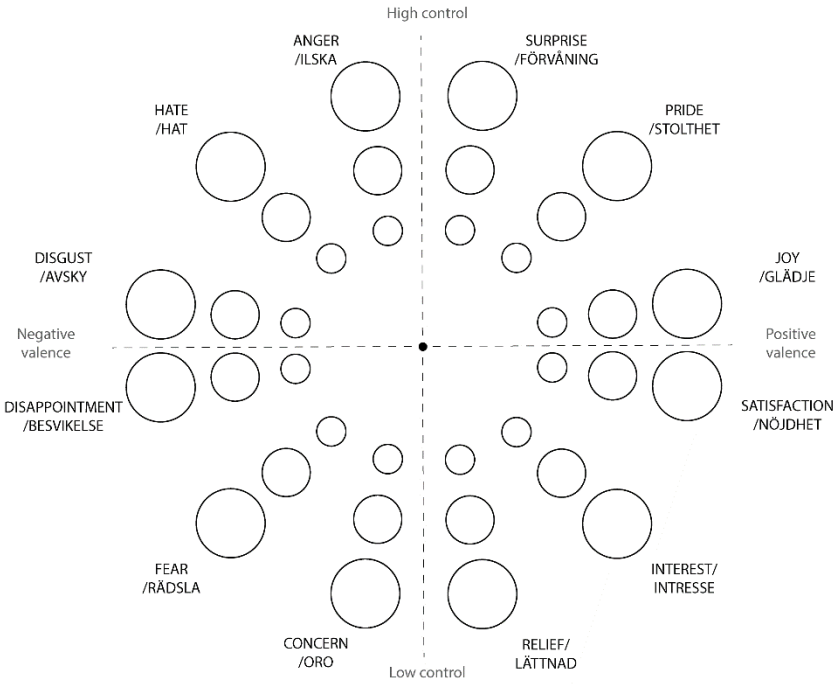
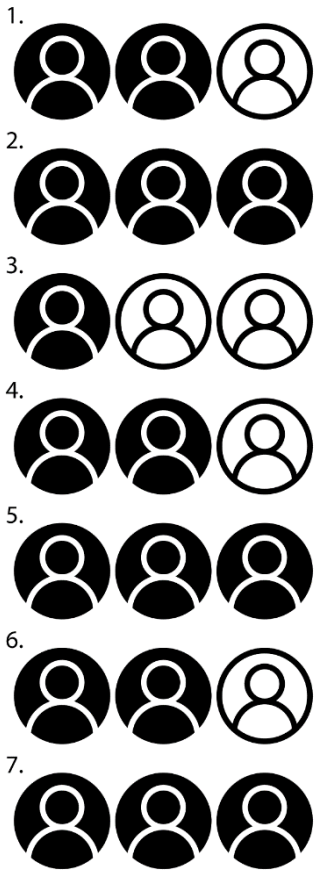


Figure 8.2 - Geneva Emotion Wheel that was used for the usability testing

8.4 Results

8.4.1 Usability testing

The success rate of the seven tasks in the user test is visualized in **figure 8.3**, in which the filled icons show the number of users that completed the task.



2 of 3 users were able to answer CAT questionnaire. An explanation of the questionnaire was given to those who were not affected by COPD, as it is a specific test for this illness.

3 of 3 users were able to do a pulse oximetry test. This is one of the most fundamental parts of Virtual Hospital and fulfills the requirement that patient should be able to do a self-care measurement.

1 of 3 users were able to check reminders for completed tests. The rest faced difficulties and needed an explanation about reminders in digital format, and their placement on the *Home screen.*

2 of 3 users were able to look up the monthly resting heart rate in *My Health* and tell the value. The last one managed navigate to the pulse interface but could not retrieve the value.

3 of 3 users were able to access the self-care plan. This meets one of the requirements to facilitate self-care for patients.

2 of 3 users were able to look up information about COPD & inhalation. The last one struggled to navigate to the specific page.

3 of 3 users were able to contact the respiratory department at Halmstad Hospital. All participants felt that the call UI was self-explanatory.

Figure 8.3 – Results from the user test

8.4.2 Pain points

The pain points found in the user test are visualized in **figure 8.4**. Uncompleted interactions and misinterpreted information are marked with red in the user interface flow chart, with the affected task stated on the side. The pain points are described below.

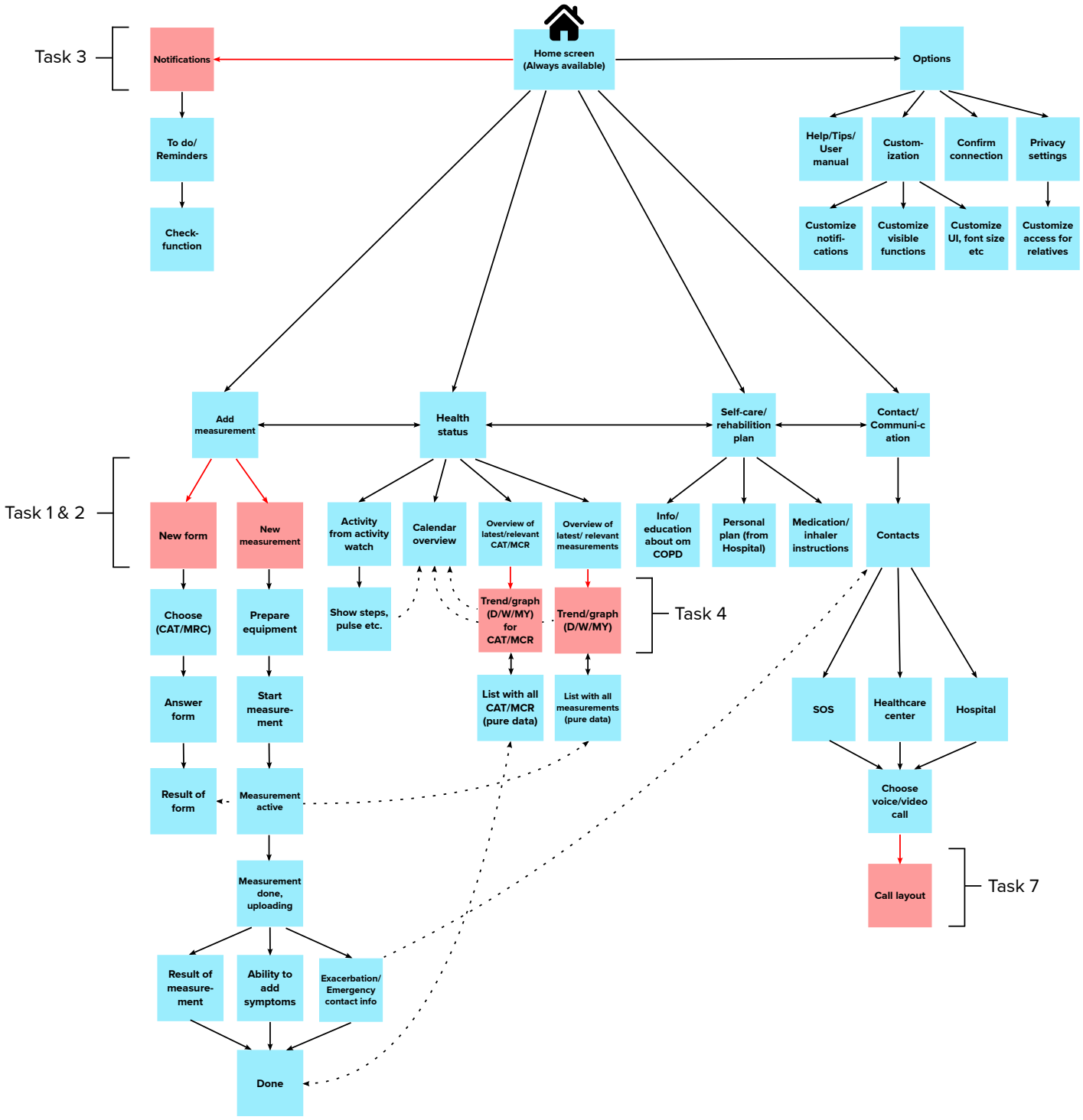


Figure 8.4 - The pain points in the interface found in the user test

Task 1 & 2

When asked to answer the CAT questionnaire, one user did not know what CAT was. On the page *Add measurement* the user did not understand the two buttons and did not find *New form.*

When asked to do a pulse oximetry test, one user did not want to press *New measurement* because of the stethoscope symbol. The user thought it meant that stethoscope examination which did not match the task. The user did not connect the symbol with self-measurement.

Figure 8.5 - Pain points on the page Add measurement found in Task 1 & 2

Task 3

When asked to check performed tests, two users did not understand that they had to go to *Reminders* to do so. One user wanted to go to *My plan* since the symbol looked like a list. The other user wanted to go to *My health* to mark the pulse oximetry test as done, since oxygen saturation was the last measured value.

At the page *Reminders,* all users could successfully mark the tasks completed. However, all users also wondered what the numbers under *Upcoming measurements* meant and found them slightly confusing.

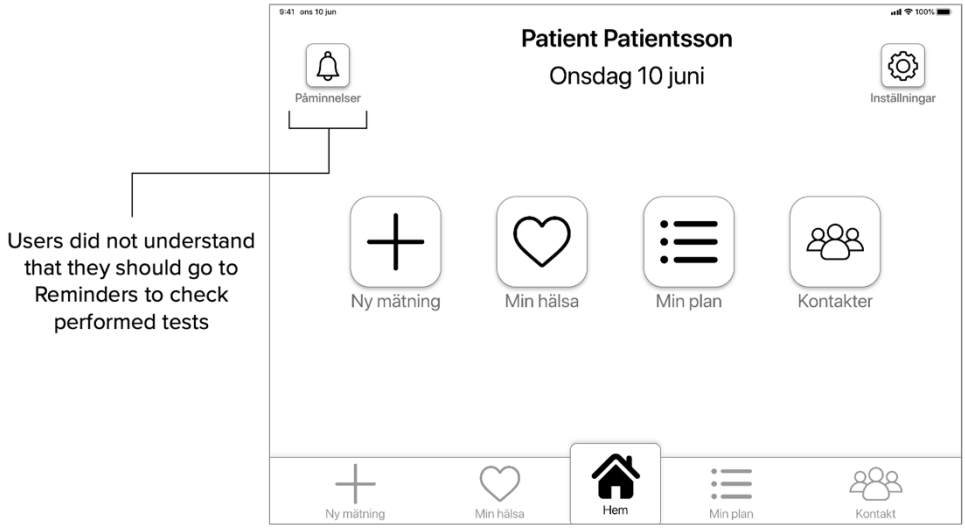


Figure 8.6 - Pain points on the page Home screen found in Task 3

Task 4

When asked to look up the monthly resting heart rate, one user did not understand that the detailed trend view of the heart rate could be reached by pressing *Pulse Range* in *My health.* The process is the same for all values, so the issue is probably also present for CAT values.

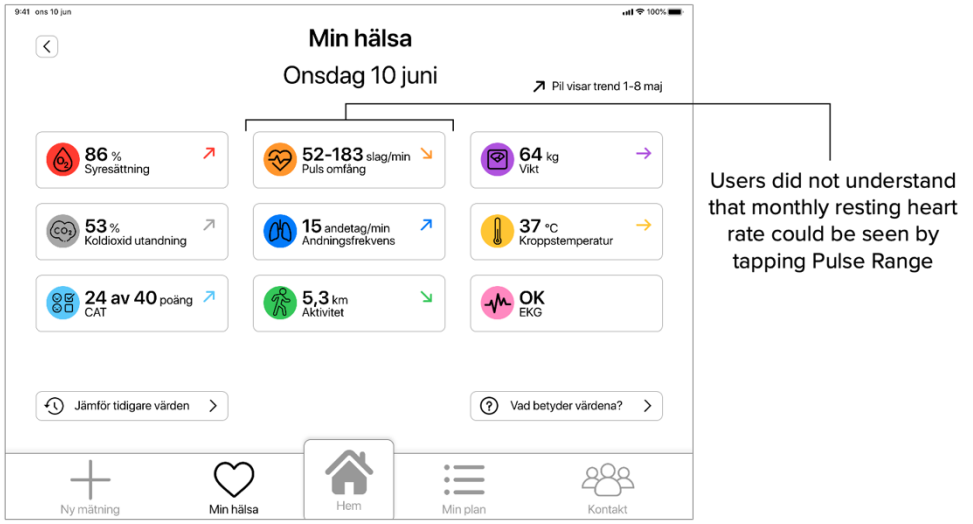


Figure 8.7 - Pain points on the page My health found in Task 4

Task 7

When asked to make a phone call to the respiratory department at Halmstad hospital, one user wanted to press the phone number text instead of the call button. The phone number text was not functional as a button, so the user failed to make the call.

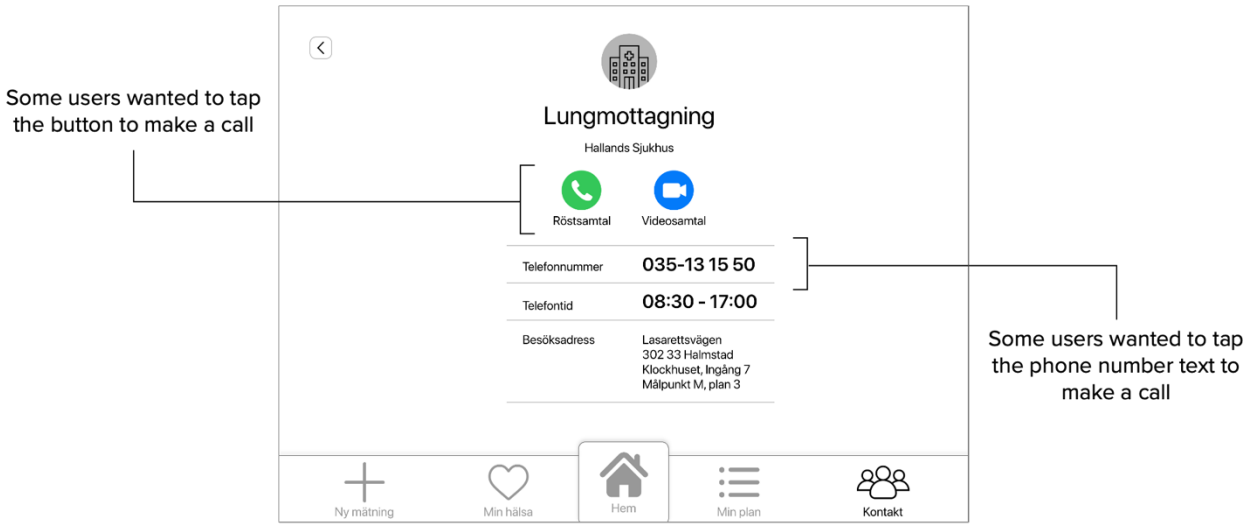


Figure 8.8 - Pain points on the page Call found in Task 7

8.4.3 Geneva Emotion Wheel

In general, the results (**figure 8.9**) for Geneva Emotion Wheel indicated that all three participants leaned towards a more positive valence (high pleasantness) comparing to the opposite area on the x-axis. Although, when comparing to the control level on the y-axis it is wider spread between high control and low control. Meaning, that participants are more related with the emotions in the two quadrants to the right for the Virtual Hospital concept. Furthermore, when looking on each emotional word that the participants felt most associated with (giving a grade more than 1), the results was; *pride*, *interest*, *joy*, *satisfaction* and fear. Contrary to the top results, the words that the participants did not feel associated with; *anger*, *hate, disgust* and *disappointment*. Noticeable, User 3 had tendency to disagree more with the rest of the group. For example, User 3 had higher emotion grade on *concern*, *disgust* and, *surprise*. The greatest difference is the *relief* emotion, which User 3 graded the lowest possible, compared to the rest of the group that graded it the highest possible.

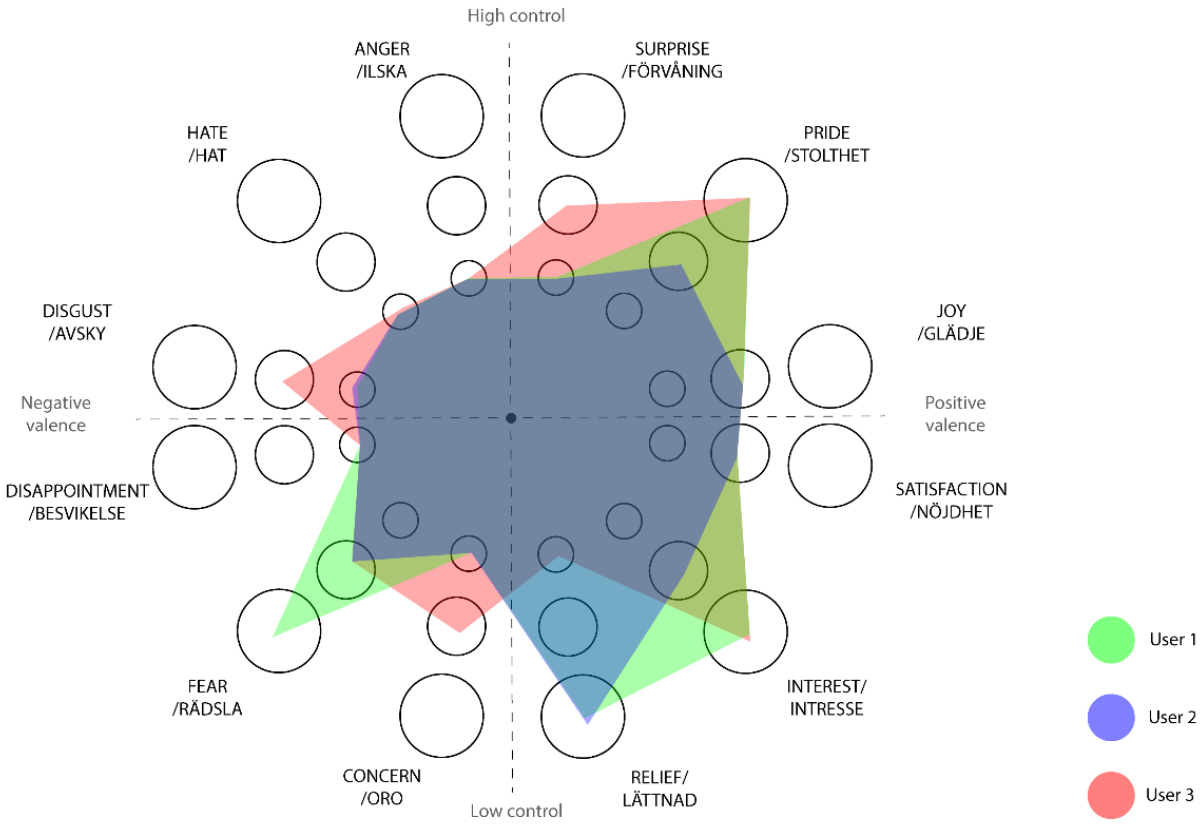


Figure 8.9 - Results of Geneva emotion wheel

8.4.4 Evaluation versus requirements

To see how well the wireframe met the demands and desires found in the Explore phase, it was evaluated versus the list of requirements for the user interface presented in section 5.4.1. The requirements have been marked as *Yes*, *No* or *Partly*, depending on how well they have been met. The list is followed by a description on how and why some of the requirements are not yet fully met.

Table 8.1 - List of requirements for the user interface with evaluation

	Requirements	Demand	Desire	Requirement met
1	The patient should be able to use the service			
1.1	The UI should explain what the measured values mean for the patient	**x**		**Yes**
1.2	The UI should adapt to the user base's technical knowledge levels	**x**		**Partly**
1.3	The system should remind the patient to take measurements		**x**	**Yes**
1.4	The system should explain how the data is shared and utilized	**x**		**No**
2	The system should enable self-care			
2.1	The UI should include self-care advice		**x**	**Yes**
2.2	The UI should encourage healthier habits		**x**	**Partly**
2.3	The system should remind the patient to follow self-care advice		**x**	**Yes**
2.4	The UI should explain use of medical devices for medication		**x**	**Yes**
3	The patient should be able to monitor the disease			
3.1	The UI should show the patient's overall health status	**x**		**Yes**
3.2	The UI should explain how to interpret the measured values	**x**		**Yes**
3.3	The UI should offer detailed views of the measured values over time		**x**	**Yes**
3.4	The UI should utilize the measured values to make the patient more engaged		**x**	**Partly**
3.5	The UI should inform the patient about its illness		**x**	**Yes**
4	The healthcare provider should be able to monitor the disease			
4.1	The system should make the measured data available for associated healthcare providers	**x**		**Partly**

4.2	The system should make CAT data available for associated healthcare providers		**x**	**Partly**

5 The system should facilitate contact between the patient and the healthcare provider

5.1	The UI should provide contact information and when to use it	**x**		**Yes**
5.2	The system should provide quick access to contact information if exacerbation is detected	**x**		**Yes**
5.3	The system should enable virtual meetings		**x**	**Yes**

6 The patient should be able to take measurements autonomously

6.1	The UI should explain how to use the measurement equipment	**x**		**Yes**
6.2	The UI should guide the user through the measurement process	**x**		**Yes**
6.3	The system should allow the patient to fill in CAT forms		**x**	**Yes**
6.4	The system should ensure measurement is correctly made for the user	**x**		**No**

7 The system should detect divergence

7.1	The UI should alert about potential exacerbations for the patient		**x**	**No**

8 The system should improve the healthcare provider's working procedures

8.1	The system needs to convince medical professional the benefits of the system	**x**		**Partly**
8.2	The system should be working remotely on portable devices		**x**	**Yes**

- **1.2** is only partly met, since the specific properties that have to be customizable have not been investigated and tested. The limited technological experience of elderly and UX guidelines regarding this have been taken into consideration, but the user group is large and diverse and therefore further personal customization seem desirable.
- **1.3** is met since the functionality of reminders is implemented, but its name and placement seemed hard to understand and it is likely that a solution more adapted to elderly can be found.
- **1.4** not met, and to implement this both the structure of the digital healthcare system and the rules in the region have to be investigated. This was considered to be outside the scope for this project. Despite this, an important part of this functionality, to show the user when data has been synced to the database, has already been implemented as it is a natural part of the measurement process in VH.

- **2.2** is partly met. There is no personal trainer in the application, but the way it presents data has the possibility to encourage exercise and other healthy habits. However, the effectiveness of this probably has to be tested and evaluated in a quantitative study to see the long-term effects.
- **3.2** is met, and the button *What do the values mean* is available both in *Measurement result* and *My health*. Which information should be included and how it best can help the patient to interpret the values has, however, to be further investigated.
- **3.4** is partly met. The *Trends* page shows the measured values and the arrows indicate if they are going up or down, which can encourage the user to make sure they are pointing in the right direction. However, the patient might need more guidance of how to turn the trend.
- **4.1** and **4.2** are partly met, since visualization of the uploading of the data is implemented in the patient's interface. A similar functionality is however, needed in the medical professionals' interface.
- **6.4** is not met, since there is no error detection in this version of the application. To communicate to the patient that a measurement is performed wrong is, however, a relatively easy function to implement into the interface. To detect when such errors are happening are probably harder and might require other types of measurement equipment. Therefore, this functionality has been left out in this project.
- **7.1** is not met. To implement this in VH, some kind of AI is needed to analyze the patient's data. In the Explore phase different opinions on this topic where found. Whether a digital healthcare system should make assessments like this or if they should only be used by a doctor seem to be an ethical issue. In this version of the application, the data is presented so that the patient or a medical professional can draw their own conclusions, but there is no automatic exacerbation detection.
- **8.1** is marked as partly met, since the application's possibility to convince medical professionals about VH has to be tested. Demonstrating the advantages with VH is an important part of the project, but to evaluate this their attitude and opinions when using it in HINT has to be investigated.

8.4.5 Virtual Hospital and the personas

To evaluate how the personas would feel using the wireframe, short user scenarios were created for the three patient personas. The wireframe is aimed at patients, so the nurse personas have not been included in this step. These personas are, however, a representation of the needs and attitudes of the real nurses that where interviewed, so the they could be useful for further development of VH.

The evaluation for the patient personas was based on how the wireframe turned out, in terms of layout, navigation and functions. The user test and the evaluation versus the requirements were used to see how well the wireframe fulfilled the personas' needs and how they would experience it.

Lennart

Lennart has had trouble following the healthcare advice that he had gotten from the hospital since he did not really understand them. He started to lose weight and experience exacerbations, and he heard that the Virtual Hospital could help him follow the advice and see his values easier. He has not got so much experience of technology and applications so at first, he was skeptical, but he decided to try it.

Lennart's goal is to do what the hospital asks of him so that he can stay healthy, and he appreciates that the application guides him through the measurement process so he does not have to worry about what values he should measure and how he should do it. He likes that the application tells him when it is time for measurement so that he does not have to think about it during the day. He like to see the value that has just been measured but is not so interested in all the old data. The routine of measuring the values and seeing if they are going up or down makes him more conscious about how his behavior affects the COPD. One time his oxygen saturation had suddenly gone down and he felt very tired, and another time he forgot how the capnograph worked, and in those occasions he managed to find the contact screen and make a video call to the COPD nurse at the hospital to get support.

He thinks it is a bit frustrating to have to press different buttons on the tablet, but since the information concerns his own health, he thinks it is worth the effort. He also finds the application easier to use than other applications that he has tested. He does not have to scroll, swipe or make other gestures, and that makes it a bit easier to understand.

Lennart is still a bit skeptical to the idea that he should take care of himself instead of going to the hospital. He thinks that since he has paid taxes all his life, the healthcare provider should have time for him when he needs it. At the same time, going on the bus and traveling to the hospital is a small project for him, so the possibility to talk to the nurses remotely is rather convenient for him, and therefore he has accepted Virtual Hospital visits between the regular yearly examinations.

Anna-Karin

Anna-Karin has been diagnosed with COPD quite recently, so she does not know so much about the disease. She has just started using the Virtual Hospital and she likes that she can read about what is really happening in the body and what all the different values mean. She has also watched the instructions on how to use the inhaler. It is a lot of new information to take in which makes her a bit stressed, but it is reassuring that she can easily get in contact with a nurse.

Anna-Karin finds it relatively easy to understand the application. She already has a tablet, so she has some experience, and she likes that the interface feels familiar and reminds her of other applications that she uses every day. Despite this, she is afraid to get lost or to do something wrong, like uploading a false value to the hospital. She has, however, found out that the home button is always there so that she can get back to the Home screen when she gets lost.

She likes the page My health best, because it gives her a quick overview of how she is doing and lets her focus on more important things in life. She also keeps an eye on the trend arrows and wants them to point in the right directions. She does Nordic walking quite often, and she thinks it is practical to see the result of her walks next to the medical values. The overview also makes it easier to discuss the disease with her children, since they can look it and point out different values. The fact that it is a new application also seem to make the kids a bit more interested.

Peo

Peo has had COPD for a couple of years and know quite well what is happening with his body and how he should use his medication. He is interested in new technology, and when he was diagnosed with the disease, he bought a pulse oximeter independently so that he could measure his own oxygen saturation. When the Virtual Hospital was introduced, he wanted to try it to see more of his own medical data.

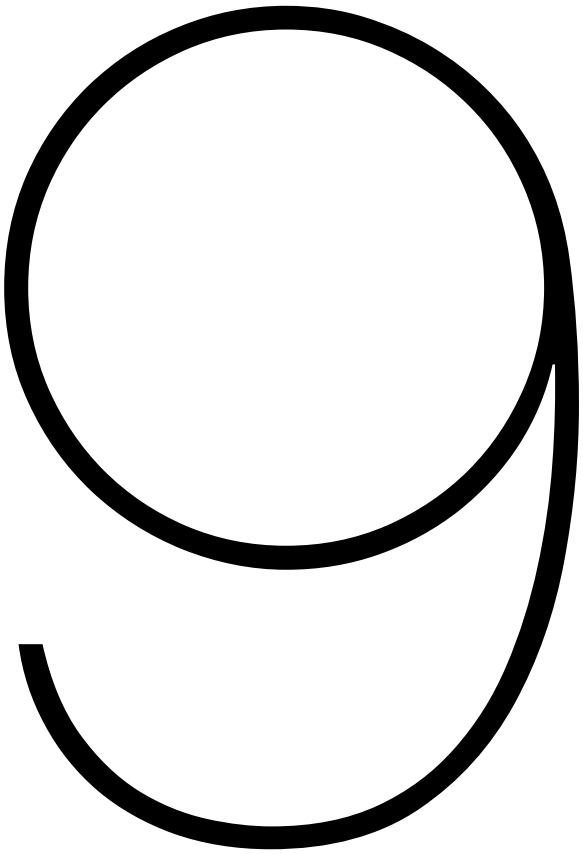
Peo likes to take care of himself and appreciates that the application gives him clear instructions on how measure his values, so he does not have to go to the hospital. He also likes that he can see the values in detail for a certain time period so that he can make his own conclusion before having to contact the hospital. He only uses the contact screen for his scheduled follow ups with the COPD nurses, but he finds it practical to be able to discuss his values with them. Peo has not really understood why he has to fill in the CAT form, but he thinks that it is convenient to make it in the application, since it means one less paper to worry about.

Peo likes to keep track of his values and the trends, and he sometimes goes to *What do the values mean* to read more about them. He is more interested in the measurement and the technology, but it seems that the Virtual Hospital has made him think more about his health as well. To better follow the rehabilitation plan, he has also turned on the reminders, so that he does not forget to do what he is advised.

8.5 Conclusion

The evaluation gives a small indication that the final concept is one way to successfully make the functionality of the Virtual Hospital accessible for patients. In general, the uncompleted tasks in the user test depend on navigation between pages and labeling of functions. When directed to the right page, the users understood the instructions given or the information presented. This indicates that further development of the structure and layout of the interface is needed, rather than a change of the basic functions.

The evaluation also shows that the final concept fulfills 16 of the 25 requirements fully, and 6 of the 25 requirements partly. This indicates that a first step towards a Virtual Hospital application has been taken with the wireframe version. Some features are still to be implemented, and the interface as a whole has to be further developed and tested, but this version offers suggestions for a majority of the functions requested by the interviewees. The persona scenarios envision how they would experience the system, and although being imaginary, the scenario shows that their different stages of illness and different experience of technology have been taken into consideration. The development of the Virtual Hospital application and the next step is discussed in detail the next chapter.



DISCUSSION

9 Discussion

9.1 The process leading to the final concept

The Virtual Hospital is a relatively complex digital healthcare system, and everyone that uses it needs an interface to be able to interact with it. Together with the client, HCH, an interface for the patient that could be demonstrated in HINT was selected as the scope for this project. This was seen as a good starting point for developing an application for the Virtual Hospital. Being able to show it inside HINT would also allow medical professionals to give feedback and decision makers to gain interest. COPD patients were selected as the target group since the disease is one of the most common chronic diseases, and since the values measured in HINT can be useful in the treatment process.

However, when the COVID-19 pandemic started to affect the Swedish society and elderly with lung disease became unavailable, the choice of target group was discussed with the client. It was agreed that the patients would be left out in this project and that medical professionals should be in focus instead. The new primary objective was decided to be development of an interface for medical professionals that would demonstrate how they could utilize the Virtual Hospital. This focus led to the interviews and workshop with professionals, in which many insights into both the patient's and the professional's perspectives was gained.

After the Define phase, when the prerequisites for the next step had been formulated in form of requirements and personas, the possibilities of using the application to involve the patient in the digital healthcare system seemed promising. In addition, the insights indicated that there are already many interfaces for visualization of medical data for medical professionals on the market, and fewer for consumers and patients. It was considered that the project would be able to provide a more valuable outcome if a digital interface for patients was developed, and therefore the authors of this report decided to continue with the original objective. The focus on demonstration of the advantages of the Virtual Hospital for medical professionals in HINT remained, and hence the functionality requested by the client would still be provided.

This led to a process in which medical professionals were used to gain insights, which was then used to develop an interface for patients. It would have been preferable to also gain insights from patients, since it would allow them to express their perspective and needs. This was, however, the best solution under the conditions of the COVID-19 pandemic. In this way, the medical professionals could contribute with their experience and medical knowledge, and the topic of visualization of medical data for consumers could still be explored. In addition, the final concept shows some advantages of using the patient as the starting point. This interface has been built

around the patient's prerequisites, and by continuing development of the digital healthcare system from here, the patient's needs can be better answered.

The design process was also affected by the pandemic to some extent. In the beginning of the project, it was planned to be an iterative process in which one or more concepts should be tested and redesigned. When this phase of the project was reached, the chance of involving patients was still low because of the social distancing recommendations, and tests and evaluation with real patients was not an option. With the goal to create an interface that would work as proof of concept for the Virtual Hospital in HINT, it was decided to go directly from ideation to a clickable wireframe version of the interface. The goal became to design and build the interface as well as possible based on all the knowledge gained up until this point and then evaluate it versus the requirements and personas.

At the end of the Create phase, however, a small group of patients with chronic diseases showed interest in contributing to the project, and a small user test was organized. This led to an Evaluation phase consisting of both the user experience test and the planned evaluation. Although it was a small user test, evaluating the user experience was interesting and it provided some useful results. Having had user experience design as a focus throughout the project, the possibility to test the page designs and the navigation was an appreciated addition to the evaluation. For instance, it is likely that the paint points identified would appear for more users than these, so this could be a good starting point for further development of the interface.

9.2 Final concept

The final concept fulfills its purpose as proof of concept for the Virtual Hospital. It is far from a complete consumer application, but it is a first step toward involving the patient in the digital healthcare system and a good example of how it could be done. For professionals that are skeptical to the idea of making the medical data available for the patient and making them more responsible for their self-care, the final concept has a chance to show the advantages.

Having taken the step from presentation of values on a screen, to a wider solution for increasing self-care is an especially satisfactory result. Combining the functionality of measurement, data overview and self-care for the patient seem to have great potential, since it brings several separate tools together into one system. Perhaps this idea could be used as unique selling point for the Virtual Hospital in the future.

The fact that Swedish healthcare faces changes over the coming years motivated us to do this project. And that the concept of Virtual Hospital could make a difference for patients, not just COPD but with any chronic diseases. Collecting more data over time will make it possible for healthcare personal to diagnose more thoroughly and individualize treatments that can result in

higher quality of life. The data is not only useful solely for doctors and nurses; giving patients access to the data, in a customer-friendly way, could help them understand their health conditions and the possibility to create patient engagement through it, with the outcome of better quality of life.

9.3 Next step

The next step for the development of an application for the Virtual Hospital is to test different aspects with a more patients and medical professionals to get better evidence of what is working and what has to change. The measurement guidance has to be reviewed, to see if the instructions are sufficient to make sure that the tasks can be performed correctly. The data presentation and the explanatory views have to be updated so that they can be interpreted correctly. The effectiveness of the digital rehabilitation plan has to be evaluated, to see if the patient's behavior actually changes. To test the application without real patient data is a limitation, since it becomes harder to connect the values to one's own health when the values are fictional. Therefore, a larger user test, over a longer time, with real data from the regional database is the next big step.

In this project, COPD has been in focus. It would be interesting to investigate for which other diseases the Virtual Hospital could be useful. The scenario has been that the patients are given access to the application and the measurement equipment when they are diagnosed with a specific disease, but perhaps an application like this could be useful in other scenarios. Some of the basic functions suggested in this version: measurement, assessment forms, data visualization, rehabilitation plans and contact possibilities, could be used in an application aimed at all individuals that are in contact with the healthcare provider. This would, however, require adding a wide variety of functions, but perhaps the basic layout can be useful.

On this topic, it would be interesting to investigate how the application can be made adaptable for different types of diseases. The user interface created in this project consists of graphical elements for presenting values, and these could be adapted to showing different selections of values for different diseases. Regarding this, the insights indicated that the medical professionals could make use of a system in which certain values and functions could be selected for specific patients with certain diseases. Involving more professions than nurses and doctors is also a way to expand the system, so interviews and tests with these is a good next step. For instance, psychologists, physical therapists and occupational therapists were discussed as potential users in the stakeholder analysis.

One of the goals with the Virtual Hospital is to decrease the patient's anxiety, but this also has to be investigated. Giving the patient access to the values without the professional interpretation from a medical professional could lead to questions and increased anxiety if the additional provided information is insufficient. However, with the aim of making the patient more engaged, the orientation in this project has been to be transparent, rather than hiding the values from the patient.

The idea is that with all the values, the trends and the information about what they mean, the patient will be able to understand what is happening and alter their behavior based on it. This is however personal, and while some patients feel calm when they know everything, other patients prefer getting the results from the medical professionals the traditional way. Therefore, it could be a good idea to make the amount of data that is shown customizable.

Regarding anxiety, measurement mistakes and system errors that risk worrying the patient must also be taken into consideration. Firstly, the measurement instructions should be optimized so that the risk for mistakes are minimized, and secondly, the medical professionals should be notified when values are unexpectedly high or low. To notice when this happens, the medical professionals could monitor the values remotely on a regular basis, but technically it could also be done automatically by the software. What is most suitable for the Virtual Hospital has to be investigated. The first step is, however, to ensure that the patient understands what is going on and feels confident, and to achieve that, the educational material connected to both the measurement procedure and the data visualization has to be sufficient.

9.4 Sustainability aspects

During this project sustainability aspects have been in focus, particularly the social aspects. One can argue that it is understandable for a project like this, although it is not evident that the end result is automatically successful. The purpose of the project has been to improve people's lives. Specifically, people that are affected by a chronic disease and their right to receive dignified healthcare despite future changes and challenges in Swedish healthcare, while being given the best possibility to still live a good life despite the disease.

Moreover, the population density in Sweden varies greatly, and so does the number of doctors per square kilometer. In rural areas the distances to a hospital or a medical center can be long and in these areas the functionality of a Virtual Hospital can increase the accessibility for the patient to continuously be in contact with the healthcare. This can certainly be important for patients with diseases that make it hard for them to travel. Reducing the number of transports connected to healthcare, for both personal and patients, can also save money in all areas of Sweden. This is specially motivated in rural areas since this is a larger cost (SALAR, 2019). The physical meeting with a medical professional can, however, allow other types of medical examination methods and increase the patient's feeling of security. Therefore, the digital interface should not replace the physical meeting with a medical professional, but rather make meetings more qualitative and perhaps less frequent. In addition to this, the data that the remote monitoring system collects can give the medical professional better insights and allow them to make a better assessment which can increase the quality of the healthcare.

In general, Sweden is considered to have one of the best internet infrastructures in the world and the Swedish government has engineered an expansion for broadband access throughout the country (Regeringskansliet, 2016). The purpose is to avoid sparsely populated areas to be excluded from the technology development, with the goal that 98 percent of the Swedish citizens should have access to an internet speed of 1 Gigabyte per second (Gbits/s) at home and at work, while 1,9% should have access to 100 Mbits/s and 0,1% to 30 Mbits/s. This means, that the prerequisite to make Virtual Hospital accessible to everyone is reasonably good no matter where the patient lives. However, there is a concern regarding whether the adaptation of Virtual Hospital for patients are considered for everyone and especially elderly who are not comfortable with technology. In 2018, the Swedish Internet Foundation (2018) reported that 500 000 people in Sweden do not use internet. Of these, 51% are 66 years or older, and every third senior in Sweden does not use internet daily. It is unclear if these people can gain any benefits of using Virtual Hospital, if they are involuntarily forced to use it. Hence, it is necessary to evaluate these circumstances further to avoid lowered quality of life for them. In addition, the solution should be used in a beneficial way to avoid creating shamefulness around the disease or more anxiety for the patients.

The distribution of the measurement equipment also has to be further investigated. If the patient needs to buy their own equipment and tablet, using the Virtual Hospital could become a privilege, i.e. it would not ensure access to good healthcare for everyone. In this project, the scenario has been that the patient gets all the necessary equipment and the tablet from the healthcare provider. This could mean increased investments for the region, and therefore the logistics of purchasing and distributing the equipment should be looked into. Another aspect is whether or not the Virtual Hospital is financially motivated for Region Halland. Apart from the equipment, the digital infrastructure, the organizational changes and the education that is needed require investments, but it has the chance to save money in the longer term. Perhaps it needs a national initiative led by for example SALAR to succeed, but hopefully our solution can be used as an example to gain interest from healthcare providers, investors and authorities in Halland and in other regions.

As mentioned above, the functionality of the Virtual Hospital can reduce the number of transports between the home and hospital. If the transport vehicles consume fossil fuel, fewer transports lead to reduced emissions of greenhouse gases. Also, the negative environmental impact of the product mostly depends on the hardware on which it is applied. By creating a user interface on an existing device as a solution it will be more resource effective than to manufacture a new, proprietary, device for every patient.

9.5 Ethical considerations

Ethics is important in all technology development, both in terms of research methods and the product outcome. In addition, one could argue that it plays an even more important role in the developments of medical technology, since it often concerns people's personal medical data. In

this project, qualitative data from interviews, workshops, and user tests have been collected and processed, but all data have been anonymized. Audio recordings and transcripts of these were stored in folder at the online storage service box.com, which Chalmers considers to be a trusted service. To ensure that the data handling followed the European legislation on personally identifiable information (e.g. GDPR), the audio recordings and transcripts were marked with pseudonyms (e.g. Nurse 1 etc.), so that they would be identifiable. Apart from the voice recordings and the transcripts, the personally identifiable information contained age, health status, living condition and profession. Consent to store the anonymized data during the project was requested orally in the beginning of the interviews, together with an explanation of how the data would be handled (see Appendix 11.1 and 11.4.).

When it comes to the result of this project, one of the central functions of the solution is that it gives the patient access to their own medical data. This type of personal medical data is normally only accessible for the healthcare provider, so making this available for the patient can increase understanding of what type of data is measured and who has access to it. In addition, the tools that are suggested for increasing self-care can increase integrity and autonomy, since they allow the patient to take active part in the treatment process, instead of just giving away the data and relying on the medical professionals to treat them.

On the other hand, data collection can decrease integrity and autonomy if not done correctly. Personal medical data can be used for both economic and political purposes if accessed by the wrong person or organization. Therefore, a remote monitoring system like the Virtual Hospital requires a high level of security. The digital infrastructure in terms of servers and data centers must be in a secure location, and the employees and the organization that handles the data must be trusted. Data storage and access is also regulated by data protections laws like GDPR, but if the technological development is fast and if the system is implemented before the legislation is adapted, the restrictions can sometimes be inefficient. Therefore, these issues have to be investigated and resolved before the Virtual Hospital is used with real patient data.

9.6 Conclusion

This thesis explores how a digital healthcare system can be made accessible for patients. The goal was to investigate who is involved in the system and how they can benefit from it. For the design process, the patients were selected as the primary user group and they have been the main focus in the creative part of the project. Their connection to the Virtual Hospital was expressed in research question one:

I. How can the Virtual Hospital enable home care and facilitate self-care for healthcare recipients?

To answer this question, the approach has been to investigate which of the procedures that are done by a medical professional at the hospital could be done by the patient at home, and what the patient needs to be able to do it. The insights indicated that home care and self-care are connected. To enable home care, the patient needs measurement equipment, the ability to use it and mediating tools to see the result. To facilitate self-care, however, the patient also needs to learn how to interpret the result and how the act upon it. This was substantiated by the skepticism towards self-care and self-measurement expressed by some of the interviewees. Therefore, teaching the user how the measurement equipment works and what the values mean has been a central part of the project. However, the insights also showed that conversations between the patient and the medical professional remain important for the assessment, which resulted in suggestions for including the medical data in a virtual meeting.

In addition, the research and benchmark studies indicated that there is a big difference between user interfaces for medical professionals and for consumers. In order to transfer assignments from the medical professionals to the patients, there seemed to be a need for a more user centered approach. Therefore, user experience design and design guidelines for the user group in focus has been applied. This has led to an interface aimed at guiding the user through the measurement process and presenting the medical data in an understandable way. These functions are then combined with the patient's rehabilitation plan, to make it easier for them to see how their values are connected to their behavior. The medical data is also utilized in a call layout that can be used for support or follow ups.

The medical professionals have not been examined as a user group in this project, but they have provided necessary insights into their work procedures and the treatment process of COPD. Their perspective was expressed in research question two:

II. How can the Virtual Hospital assist healthcare providers and what information do they wish to communicate through the interface?

This question is connected to the implementation of digital healthcare systems in society and how they can be used to meet the increasing load on the healthcare sector. In this project, the question has led to the investigation of the healthcare provider's work procedures and how they can be improved by the Virtual Hospital. This includes the interviews and the stakeholder analysis and resulted in a knowledge basis of how different professions could make use of the system. Increasing self-care to decrease the workload in the healthcare sector is a central part of the Virtual Hospital, and if it succeeds it will be beneficial for the medical professionals. The insights in this project indicates that some tasks are more suitable to perform by the patient than others, and that the medical professionals still prefer to perform some measurements and examinations themselves. Therefore, the goal has been to implement the most suitable procedures as functions in the interface. Apart from the measurement process, a functionality that was requested by HCH, a digital CAT form has been implemented to facilitate assessment of the patient’s health and well-being. A way to provide a digital rehabilitation plan with reminders to help following it, and instructions for inhaler medication, have also been proposed.

The final concept should, however, be seen as a suggestion. These are the functions that have been found suitable in this project, but it is only the first step in the development of an application for the Virtual Hospital. The interface has to be connected to the database, so that patients can try the system with their own medical data over a longer time, to evaluate if their health is affected. The measurement instructions and the educational features have to be reviewed, to see if the guidance and information is sufficient to maintain patient safety. In addition, the user experience of the interface also has to be further evaluated, to see if information and navigation is understandable. The insights also indicate that there is a need to investigate in which situations it is appropriate to use the Virtual Hospital. The system must be used to improve the patients' situation and to increase their quality of life. In many cases, humans cannot be replaced by machines, so the system should not be used to cut down on staff and decrease healthcare quality. Instead it should be used increase efficiency to meet the increasing load on the healthcare, and to improve comfort and engagement for the patients.

Exploring this topic has shown that there is a need for involving the patient in the digital healthcare system. The patients and the medical professionals have both shown high interest and engagement. The possibilities of guiding the patient through measurement and teaching them to interpret and improve their values seem to be great. The hope is that the Virtual Hospital will make the patients more independent and give them a higher quality of life.

10

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10

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10.2 Figure References

Figure 2.5a

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Figure 2.5c

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Figure 2.5d

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Figure 2.5e

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Figure 3.1, Figure 3.2 and Figure 3.4

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Figure 3.3

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Figure 3.6

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11

APPENDICES

11 Appendices

11.1 Guide for interviews with medical professionals

(Translated, the interview was conducted in Swedish)

In general about their role for the stakeholder analysis

General for all questions: Don't forget to ask follow-up questions like how? and why? if the answer is not clear enough.

“Is it okay for us to record this interview? The recording will only be used to analyze data and will only be read by us and Hälsoteknikcentrum Halland. The data that will be saved are the audio recording, your age, your professional role and your duties. Other information will be anonymized. Is it ok that we save your anonymized data after the project has been completed? Is it ok if we mention you as (e.g.) X-year COPD nurse etc. in our publishable report? You can cancel at any time during the interview. "

- What are your tasks in the treatment of COPD?

- How often do you meet COPD patients?
    - What takes the most time? What is most demanding?

- Do you think that any work can be relieved? I.e. can some work be put on the patient instead?
    - What had made a difference to you?

- How do you get an overview of a patient's problems?
    - What values are you interested in?
    - What are the priorities for facilitating your work?

- What is important is social contact for the patient?
    - How important is social contact compared to medical treatment?

- What other people are involved in the treatment of COPD?

Thoughts about VH and input to the solution

"Now we will talk more in-depth about the virtual hospital concept and ask you questions about this."

"The basic idea is that patients themselves should be able to measure their values in the home and that these should be sent to various institutes in the health care system that get more data and can monitor the disease remotely. Compared to today, when values are measured only during hospital visits. The purpose is also for the patient to get an overview of their condition and become more involved, so that self-care is possible."

- What do you think of the idea of a virtual hospital?

- Would you be able to benefit from these values in your work?
    - How? / Why not?

- What advantages and disadvantages do you see with the patient measuring the values himself?
    - What is needed for the patient to manage the measurements himself?

- Do you think this data might be of use to the patient?
    - What do you think of the idea that patients can access more information about their health status? Maybe they just get it from you.
    - What do you think are the advantages or disadvantages?
    - What type of data do you think may be relevant to patients?

- When it comes to the software solution itself, do you want it to be passive and just collect data, or do you want it to be active and e.g. warn and indicate?
    - What do you think are the advantages and disadvantages of it?

- Is it good or bad if physical hospitals visits are reduced?

    - If physical visits are reduced then the social presence will also partially disappear, how can the social contact with patients be maintained?

- What do you think of the idea of integrating patients' rehabilitation programs into VH?

- What additional features do you think can make your job easier?
    - Which other actors could benefit from the system?
    - What additional features do you think can create added value for patients?
    - What other diseases could benefit from Virtual Hospital?

11.2 CHAI matrix

Roller

Aktörer

	Initiatörer	Sponsorer	Övertygare	Förändrings-ägare	Mottagare/ Drabbade	Blockerare	Lösnings-skapare	Dokumenterare
Patienter	Jätteviktig uppmärksammare som ger idéer. Tar upp problem kring sjukdomen, men ej kring digital vård.				Drabbas av förändringen. De måste interagera med en ny tjänst från sjukvården. Påverkas i sitt hem, de får en lösning som de ska vara aktiva i.		Bör och ska vara en del av skapa lösningen, genom att bidra med erfarenhet, expertis och feedback kring vad som behövs.	
Sjuksköterska	Kan uppmärksamma problem på arbetsplatsen.			Får i uppdrag att förändring genomförs. Har även mandat att säga till ifall systemet inte är patientsäkert och behöver förändras.	Drabbas av förändringen då de måste använda systemet.	Kan finnas motstånd mot att införa nya digitala system i överpopulerad infrastruktur. Kan bli blockerare indirekt om tid och andra resurser saknas. Intressekonflikter kan uppstå om de inte får vara medskapare.	Bidrar med erfarenhet, expertis och feedback.	Kan vara med och utforma både problemformulering och krav, men har ingen formell uppgift att dokumentera projektet.
Undersköterska	På vissa enheter väldigt stark initiatör till att införa nya system.				Mer indirekt. SSK delegerar till USK i hälso- och sjukvårdsinsatser. Är SSK med på tåget så är USK van vid att bli delegerade och lära sig arbetsgången.	Systemet kan definitivt vara ett hot mot ett invant sätt att arbeta.	Mer indirekt. Inte lika mycket inflytande i utformningen. Har inget mandat att säga hur lösningen borde se ut, men har en roll i implemen-teringen, de vet hur det bör införas i patientens hem. Har viktig feedback, då de är närmast pat.	
Läkare	Högt upp i hierarkin, har koll på problemen och beslutskraft. Många Läk och SSK har även politiskt inflytande och kan driva denna fråga. För upp problemet på agendan.		Beror mycket på om det är hemsjukvård eller specilastsjukvård t.ex, ibland har de alla roller utom sponsor och ibland är det knappt med alls.		Utför vård med hjälp av systemet. Beror på typ av läkare, vissa kan vara drivande i detta, vissa är inte alls involverade. De blir mottagare då tar del av datan i systemet i sitt arbete.		Bidrar med sina behov i arbetet.	
Psykologer					Kan använda VH eftersom patienten vill komma i kontakt med alla roller i vården, däribland sin psykolog. Uppföljning, formulär, videosamtal och livsstilspåverkan.			
HCH	Uppmärksammar projektet snarare än problemet. HCH fick uppdraget att starta igång projektet, utan HCH hade prototypen inte funnits.	Upprätthåller förändringens legitimitet. Hanterar resurser. Dock är inte HCH en sponsor i sig, men har koppling till sponsorer, t.ex. EU och Region. Stämmer delvis.	Samlar underlag för att bevisa att behovet för förändringen finns.	Ägarskap av projektet ligger hos HCH idag, mer specifikt hos styrgruppen, som leder arbetet.			Aktiva i projektet, driver förändringen. Bidrar till utformning. Syftar dock på en mer genomförande del av HCH, ej på styrgruppen.	Dokumeterar problemformuleringen och förändringen.
Vårdcentral			Påtalar att förändring behövs.	Måste vara med och ha ägarskap på något sätt.	Hela verksamheten påverkas.	Alla delar måste vara på för att cirkeln ska vara sluten. Tidsbrist kan blockera, om de inte har tid att vara delaktiga i projektet .	Tvungna eftersom vi måste förstå deras behov och förutsättningar.	
Verksamhets-utvecklare	Kan ta upp problemet på agendan.		Naturligt i deras roll att övertyga. Vill verkligen vara med i projektet och utveckla.	Har mandat att avgöra när förändring är genomförd. De kan hjälpa vården.	Drabbas indirekt. Är lite vid sidan om den operativa verksamheten men blir påverkade av vad som händer och ska hjälpa till.		Deltar i ta fram lösningen.	Behöver ha koll på och dokumetera krav och problem i förändringen.
Enhetschefer (I kommun, hemsjukvård, hemtjänst)				Gäller för enhetschefer ansvarar för SSK. De måste legitmiera detta. Ansvarig för grupp, ekonomiskt.	Ej mest drabbade, men det påverkas indirekt deras verksamhet.	Gäller för enhetschefer som ansvar för USK. En avgörande faktor för förändringen är om tekniken fungerar eller ej. Om det blir stora förändringar för vårdspersonal i hemmet. De som avgör om det ska prioriteras eller inte.		
Styrgruppen på HCH	Olika representanter från ansvariga områden, inkl. region, sjukhus, högskolan sitter med i gruppen. De är ansvariga att dra igång för förändringen.	Inte nödvändigtvis med pengar men stödjer legitimitet.	Specialmott. är de som måste övertyga för patienten om förändringen. T.ex. Markus Lingman använder statistik för att övertyga. Styrgruppen är med i processen av förändringen.	Delvis den rollen inte helt. Gruppen genomför ej, men har mandat att avgöra när förändring är gjord/klar.		De kan besluta att ändra/styra eller försena olika projekt. De kan bestämma att söka pengar för ett helt andra projekt. Olika åsikter, HCH driver projektet.		VH kan ses som huvudprojektet där styrgruppen bör ansvara för att godkänna problemformulering och krav som senare mynnar ut i flera delprojekt. Ansvarar för att projektet dokumenteras.
Arbetsterapeut och Fysioterapeut					Kan vara det också, beror på hur de tas med i projektet. Viktigt att involvera dem om projektets förändring.	Mer intressant om man fokuserar på helheten av patientens liv. De kan ha andningtränare etc. När deras involvering är aktuell så kan de vara både blockare och lösningsskapare. Viktigt att aktörer är upplyst om förändringen annars riskerar den att blockera förändringen	När deras involvering är aktuell så kan de vara både blockare och lösningsskapare	
Projektekonom (HCH)						Kan säga att budget är slut t.ex. Men beror i så fall på att någon annan dragit in finansiering. Mellanfunktion mellan förändringsäagre och blockerare t.e.x		Ansvarar för redovisning av ekonomin av projektet
Specialistmott.	De som funnit ett behov i vården. Dvs. kunna mäta värdena hemifrån utan att behöva åka in. Från kommunperspektiv gör VH att det blir mer jobb för kommunen och avlastar specialistmot. Dock står rollen i konflikt då ledningen på specialistmott. är den som initierar förändringen och inte möjligtvis läkare,SSK,USK.	Sjukhusledningen som motiverar och stödjer förändringen	Mottagningen måste bli övertygare mot patienten, för att övertyga att använda VH.	Vissa specialistläkare sitter med i sjukhusledniq och pushar för förändring till övriga på mottagning.	Vårdpersonalen på mott. kommer vara användare av VH-systemet. Gäller ej för styrelsen på mott.	Vårdpersonalen på mott. kommer vara användare av VH-systemet. Initial reaktion är rädd att förlora jobb när arbetsuppgifter ersätts av digitalt system. Finns med i alla förändringsarbeten.	Är de som utformar kraven av data (vitala parameterar) som behövs för att förändringen ska vara möjlig. Hur de ska kunna utföra sitt jobb på bästa sätt	

11.3 List of Requirements for the Virtual Hospital system

	Requirement	Demand	Desire
1	The patient should be able to use the service		
1.1	The UI should explain what the measured values mean for the patient	**x**	
1.2	The UI should adapt to the user base's technical knowledge levels		**x**
1.3	The system should remind the patient to take measurements	**x**	
1.4	The system should explain how the data is shared and utilized	**x**	
1.5	The user should be able to customize what is shared to relatives		**x**
2	The system should enable self-care		
2.1	The system should facilitate self-care	**x**	
2.2	The UI should include self-care advice		**x**
2.3	The UI should encourage healthier habits		**x**
2.4	The system should remind the patient to follow self-care advice		**x**
2.5	The UI should explain use of medical devices for medication		**x**
2.6	The system should adapt the self-care advice based on the patient's conditions and prerequisites		**x**
3	The patient should be able to monitor the disease		
3.1	The UI should show the patient's overall health status	**x**	
3.2	The UI should explain how to interpret the measured values	**x**	
3.3	The UI should offer detailed views of the measured values over time		**x**
3.4	The UI should utilize the measured values to make the patient more engaged		**x**
3.5	The UI should inform the patient about its illness		**x**
3.6	The UI should limit the amount of daily measurements to avoid obsession	**x**	
4	The healthcare provider should be able to monitor the disease		
4.1	The system should collect and store data from the measurement equipment	**x**	
4.2	The system should make the measured data available for associated healthcare providers	**x**	

4.3	The system should show make CAT and MRC data available for associated healthcare providers		**x**
4.4	The UI should show the patient's overall health status	**x**	
4.5	The UI should offer detailed views of the data for a scalable time period	**x**	
4.6	The UI for the medical profession should have similar UI as for the patient's UI	**x**	

5 The system should facilitate contact between the patient and the healthcare provider

5.1	The UI should provide contact information and when to use it	**x**	
5.2	The system should provide quick access to contact information if exacerbation is detected	**x**	
5.3	The system should enable feedback from a healthcare provider on measurement		**x**
5.4	The system should enable virtual meetings		**x**

6 The patient should be able to take measurements autonomously

6.1	The measurement equipment should be usable by the patient	**x**	
6.2	The UI should explain how to use the measurement equipment	**x**	
6.3	The UI should guide the user through the measurement process	**x**	
6.4	The system should allow the patient to fill in CAT and MRC forms		**x**
6.5	The system should ensure measurement is correctly made for the user	**x**	
6.6	Hemtjänst/Hemsjukvård should assist the patient when taking measurements		**x**

7 The system should detect divergence

7.1	The system should be active and detect exacerbations		**x**
7.2	The UI should alert about potential exacerbations for the patient		**x**
7.3	The UI should alert about potential exacerbations for the healthcare provider		**x**
7.5	The healthcare provider should be able to customize individual threshold values for the patient		**x**

8 The system should improve the healthcare provider's working procedures

8.1	The system should be designed to decrease work load	**x**	
8.2	The system should adapt, interact and integrate to already existing system	**x**	

8.3	The system should facilitate management of multiple patients	**x**	
8.4	The system needs to convince medical professional the benefits of the system	**x**	
8.5	The system should be working remotely on portable devices		**x**

11.4 Guide for user test

(Translated, the test was conducted in Swedish)

Interview ID

“Is it okay for us to record this interview? The recording will only be used to analyze data and will only be read by us and Hälsoteknikcentrum Halland. The data that will be saved are the audio recording and video recording from the iPad, your age, COPD status and your technical experience. Other information mentioned will be anonymized. Is it ok that we save your anonymized data after the project has been completed? Is it ok for us to mention you as (e.g.) 65-year-old COPD patient etc. in our publishable report? You can cancel at any time during the interview. "

Start

- Capture information about the test subjects
- COPD status, Age
- Attitude to technology
- Computer habits they have today

View the VH and the system image for the test subject

"The basic idea is that patients themselves should be able to measure their values in the home and that these should be sent to different institutes in the healthcare system that gets more data over a period of time. Compared to today, when values are measured only during hospital visits. We also have a list of the equipment that is included."

Introduce the app and let them play around

Tell them it's just a wireframe and an early stage.

What is wireframe?

"Wireframe is an early stage in an app/program where you have not decided what the graphics should look like, but you still want to develop a basis on how the app should work and get feedback quickly without putting too much work on the design you may need redo or remove. This app is in this stage right now and your input is valuable to us for an evaluation if this is the right path.

Some text has been replaced with “lorem ipsum” to act as placeholder. Some features will not work fully either, but we will point that out."

To keep in mind for us as interviewers

- Ask users to state what they are thinking as they use the system
- Do not help the user
- Prompt user to think aloud to break silence
- Carefully record users' actions / words
- Beware interpretation (Slows user down, may improve performance)

Scenario to perform the tasks

1. **Complete CAT forms**

In normal cases, a CAT form is usually answered at the hospital. With a virtual hospital, the tester is put in a scenario where they must respond to a CAT form before they visit the hospital.

2. **Ask the tester to make a measurement with his pulse oximeter**

The tester should perform a pulse oximeter measurement when the hospital has said that this should be done once a week according to the self-care plan.

3. **Ask them to tick off completed measurements in Reminders**

To keep track of the number of things to be done, there are reminders where you can get an overview and be able to tick off.

4. **Look at My Health**

Show the picture of all equipment included in HINT.

It is now possible to use all the values taken to get an overview of their health status from all equipment. This is in My Health. Check out all the values and then your heart rate. Check heart rate values over one month for resting heart rate.

5. **Look at the self-care plan**

One possibility with VH is to be able to take part of the self-care plan in digital format directly in the program. This is to remind the patient, but also not to lose their self-care plan. We want you

now to go to My Plan and check out the medication plan. After that, you are curious to learn more about COPD and inhalation technology. It is rumored that it may be the next part of the equipment that will be included in virtual hospital.

6. Contact the lung

Due to the situation, it is possible to conduct appointments remotely with their doctor/nurse. We would like to ask you to contact the lung reception in Halmstad by video call.

7. Opinions about options

11.5 Form for user test

Testperson: _____ Ålder: _____ KOL-status: _____

Attityd till teknik:

_____

_____

_____

_____

_____

Teknikerfarenheter:

_____

_____

_____

_____

_____

		Ja	Nej
1	Svara på ett CAT-formulär		
2	Genomföra en mätning med pulsoximeter		
3	Be dem checka av Påminnelser av genomförda mätningar		
4	Få reda på vilopulsen för en månads tid i Min Hälsa		
5	Titta på egenvårdsplanen för medicin		
6	Titta på informationen om inhaleringsteknik & KOL		
7	Ta kontakt med lungmottagningen på Halmstad		
8	Ändra en toggle i inställningar		

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